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DOE/MA-0064/4
Volume 6 of 7

Congressional Budget Request

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Fossil Energy Research and Development
Naval Petroleum and Oil Shale Reserves

Volume 6

FY 1987

U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller

February 1986

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DOE/MA-0064/4
Volume 6 of 7

Congressional Budget Request

Fossil Energy Research and Development
Naval Petroleum and Oil Shale Reserves

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U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller
Washington, D.C. 20585

February 1986

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DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

CLEAN COAL TECHNOLOGY

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

NAVAL PETROLEUM AND OIL SHALE RESERVES

VOLUME 6

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DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

(in thousands of dollars)

	FY 1985 Actual BA	FY 1986 Estimate BA	FY 1987 Request BA
Appropriations Before The Energy and Water Development Subcommittees:			
Energy Supply Research and Development	1,967,490	1,696,298	1,254,162
Uranium Enrichment	237,956	190,512	---
General Science and Research	724,860	655,928	773,400
Atomic Energy Defense Activities	7,322,321	7,231,664	8,230,000
Departmental Administration	128,602	150,319	151,082
Alaska Power Administration	3,233	3,245	2,881
Bonneville Power Administration	284,771	330,000	276,100
Southeastern Power Administration	35,744	---	19,647
Southwestern Power Administration	31,208	29,191	25,337
Western Area Power Administration	218,230	195,910	240,309
Western Area Power Emergency Fund	---	---	---
Federal Energy Regulatory Commission	54,543	41,989	20,325
Nuclear Waste Fund	327,669	499,037	769,349
Geothermal Resources Development Fund	121	69	72
Subtotal, Appropriations Before the Energy and Water Development Subcommittees	$11,336,748	$11,024,162	$11,762,664

DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

(in thousands of dollars)

	FY 1985 Actual BA	FY 1986 Estimate BA	FY 1987 Request BA
Appropriations Before Interior and Related Agencies Subcommittees:			
Alternative Fuels Production	$ 1,169,895	$ ---	$ ---
Clean Coal Technology	---	---	---
Fossil Energy Research and Development	289,048	311,954	82,767
Naval Petroleum and Oil Shale Reserves	156,874	13,002	127,108
Energy Conservation	457,436	427,512	39,433
Energy Regulation	27,139	23,423	21,850
Emergency Preparedness	6,045	5,750	6,044
Strategic Petroleum Reserve	2,049,550	107,533	---
Energy Information Activities	60,919	57,724	59,651
Subtotal, Interior and Related Agencies Subcommittees	4,216,906	946,898	336,853
Subtotal, Energy and Water Development Subcommittees	11,336,748	11,024,162	11,762,664
Subtotal, Department of Energy	15,553,654	11,971,060	12,099,517
Permanent - Indefinite Appropriations:			
Payments to States	1,052	570	570
Total, Department of Energy	$15,554,706	$11,971,630	$12,100,087

Department of Energy
F Y 1987 Congressional Staffing Request
Total Work Force

	FY1985 FTE USAGE	FY1986 CONGR REQ	FY1987 -FY86	FY1987 CONGR REQ
ENERGY & WATER SUBCOMMITTEE				
HEADQUARTERS	4,865	4,965	-18	4,947
FIELD	9,133	9,185	111	9,296
SUBCOMMITTEE TOTAL	13,998	14,150	93	14,243
INTERIOR SUBCOMMITTEE				
HEADQUARTERS	1,353	1,304	-166	1,138
FIELD	907	896	-226	670
SUBCOMMITTEE TOTAL	2,260	2,200	-392	1,808
GRAND TOTAL	16,258	16,350	-299	16,051
ADJUSTMENT		-132	-198	-330
ADJUSTED TOTAL	16,258	16,218	-497	15,721

DEPARTMENT OF ENERGY
F Y 1987 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1985 FTE USAGE	FY1986 CONGR REQ	FY1987 -FY86	FY1987 CONGR REQ
10:ENERGY SUPPLY RESEARCH AND DEV	937	934	-34	900
HEADQUARTERS	811	820	-28	792
FIELD	126	114	-6	108
15:URANIUM ENRICHMENT	69	66	1	67
HEADQUARTERS	58	55	1	56
FIELD	11	11	0	11
20:GENERAL SCIENCE AND RESEARCH	37	39	0	39
HEADQUARTERS	37	39	0	39
25:ATOMIC ENERGY DEFENSE ACTIVITI	2,618	2,702	131	2,833
HEADQUARTERS	496	518	9	527
FIELD	2,122	2,184	122	2,306
30:DEPARTMENTAL ADMINISTRATION	3,307	3,332	-5	3,327
HEADQUARTERS	1,721	1,726	0	1,726
FIELD	1,586	1,606	-5	1,601
34:ALASKA POWER ADMINISTRATION	37	38	0	38
FIELD	37	38	0	38
36:BONNEVILLE POWER ADMIN	3,510	3,480	0	3,480
FIELD	3,510	3,480	0	3,480
38:SOUTHEASTERN POWER ADMIN	38	40	0	40
FIELD	38	40	0	40
42:SOUTHWESTERN POWER ADMIN	186	186	0	186
FIELD	186	186	0	186
46:WESTERN AREA POWER ADMIN	1,181	1,160	0	1,160
FIELD	1,181	1,160	0	1,160
50:WAPA - COLORADO RIVER BASIN	219	219	0	219
FIELD	219	219	0	219
52:FEDERAL ENERGY REGULATORY COMM	1,617	1,659	0	1,659
HEADQUARTERS	1,617	1,659	0	1,659
54:NUCLEAR WASTE FUND	238	292	0	292
HEADQUARTERS	123	147	0	147
FIELD	115	145	0	145
56:GEOTHERMAL RESOURCES DEV FUND	2	1	0	1
HEADQUARTERS	2	1	0	1
65:FOSSIL ENERGY RESEARCH AND DEV	714	700	-161	539
HEADQUARTERS	151	135	-26	109
FIELD	563	565	-135	430
70:NAVAL PETROL & OIL SHALE RES	104	104	-9	95
HEADQUARTERS	23	23	0	23
FIELD	81	81	-9	72
75:ENERGY CONSERVATION	333	352	-134	218
HEADQUARTERS	208	227	-79	148
FIELD	125	125	-55	70
80:EMERGENCY PREPAREDNESS	74	71	0	71
HEADQUARTERS	74	71	0	71
81:ECONOMIC REGULATION	377	340	-50	290
HEADQUARTERS	377	340	-50	290
85:STRATEGIC PETROLEUM RESERVE	178	152	-32	120
HEADQUARTERS	40	27	-5	22
FIELD	138	125	-27	98
90:ENERGY INFORMATION ACTIVITIES	480	481	-6	475
HEADQUARTERS	480	481	-6	475
94:ADVANCES FOR CO-OP WORK	2	2	0	2
FIELD	2	2	0	2
GRAND TOTAL	16,258	16,350	-299	16,051
ADJUSTMENT		-132	-198	-330
ADJUSTED TOTAL	16,258	16,218	-497	15,721

Department of Energy
FY 1987 CONGRESSIONAL BUDGET
MAJOR ACTIVITY OVERVIEW

Clean Coal Technology Program

Background

Coal is the most abundant energy resource in the United States with recoverable reserves estimated to be 935 billion barrels crude oil equivalent (COE). However, petroleum and natural gas, whose proven reserves are estimated to be 28 billion barrels and 35 billion barrels COE respectively, are the most utilized fossil fuels in the U.S. energy consuming marketplace despite their significantly higher costs relative to coal. Even though oil and natural gas prices are projected to remain significantly higher than coal, their demand is expected to remain relatively the same as it was in 1984. Coal, primarily a utility and large industrial boiler fuel, is not expected to significantly penetrate the light industrial, commercial, residential or transportation sectors now dominated by oil and natural gas.

Coal is demand driven. The capacity exists to increase coal supplies to meet significant increases in demand. To make coal utilization look more attractive, the Department of Energy and the private sector have been conducting research through proof-of-concept on a wide variety of coal technologies aimed at improving the economics of using coal, improving the environmental performance associated with the use of coal and converting coal into forms that could allow it to be used as a lower cost substitute to oil and natural gas.

On December 19, 1985, P.L. 99-190, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1986, and for Other Purposes," was signed into law. This statute, among other things, provides funds to conduct cost-shared clean coal technology projects for the construction and operation of facilities that would demonstrate the feasibility of future commercial applications of such technology.

P.L. 99-190 makes available a total of $397.6 million for this program, as follows: $99.4 million in FY 1986, $149.1 million in FY 1987, and $149.1 million in FY 1988. Funding is provided from the $397.6 million for contracting, travel, and ancillary costs incurred by the Department of Energy for implementation of the Clean Coal Technology Program. P.L. 99-190 also requires a minimum of 50 per centum cost sharing by the private sector on each project, cost sharing in each phase of each project, constraints on valuation of "in-kind" cost sharing by the private sector, time limitations for issuing the solicitations, proposal preparation and project selection(s), among other things.

The Clean Coal Technology Program is related to, but not directly a continuation of, the effort that was undertaken by DOE pursuant to Section 321 of the "Act Making Continuing Appropriations for Fiscal Year 1985," P.L. 98-473, 98 Stat. 1874. Section 321 directed the Secretary of Energy to solicit from the private sector "statements of interest in, and proposals for projects employing emerging clean coal technologies," analyze the information received, and submit a report to Congress that "assesses the potential usefulness of each emerging clean coal technology... and ...identifies the extent to which federal incentives, including financial assistance, will accelerate the commercial availability of these technologies." In response to the November 27, 1984, Program Announcement, 49 Fed. Reg. 46696, DOE received one hundred and seventy-five submissions with project values totaling over $8 billion. On May 1, 1985, DOE submitted its findings in the "Report to Congress on Emerging Clean Coal Technologies" (DOE/S-0034).

In August 1985, the President signed into law H.R. 2577, "Making Supplemental Appropriations for the Fiscal Year Ending September 30, 1985, and for Other Purposes."

The Conference Report 99-236 accompanying H.R. 2577 advised DOE to immediately begin the preparation of a competitive solicitation for cost-shared clean coal technology projects, to consult with the Environmental Protection Agency (EPA) on technologies traditionally supported by EPA and on environmental regulatory considerations, and provided guidelines for the preparation of the solicitation in addition to those cited earlier in the accompanying Senate Report 99-82.

Program Goals and Objectives

The overall goal of the Clean Coal Technology Program is to conduct cost-shared construction and operation of clean coal technology projects to demonstrate the feasibility of future commercial applications of these technologies. When complete, it is expected that these demonstration projects will provide sufficient technical, economic, environmental, health and safety, and operational information at a large enough scale to enable the private sector to make rational commercialization decisions.

It is the intent of the Department to meet this goal in accord with the following program objectives:

- Issue a competitive solicitation for Federal assistance to the private sector applicable to the broad array of coal-based emerging clean coal technology systems for use in all energy market applications.
- Enter into cost-shared cooperative agreements with the private sector to demonstrate selected systems.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
CLEAN COAL TECHNOLOGY
ENERGY SECURITY RESERVE
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Clean coal technology (FE)					
Cooperative agreements:					
Operating expenses	$ ...	$97,909	$97,909	$147,112	$+49,203
Subtotal	...	97,909	97,909	147,112	+49,203
Program direction:					
Operating expenses	$ ...	1,491	1,491	1,988	+497
Subtotal	...	1,491	1,491	1,988	+497
Total					
Operating expenses	...	99,400	99,400	149,100 1/	+49,700
Clean coal technology	$ ...	$99,400	$99,400	$149,100	$+49,700

1/ FY 1987 funding was made available via the FY 1986 Continuing Resolution.

Authorization: P.L. 96-126, P.L. 98-473
P.L. 99-190

Summary of Changes

FY 1986 Appropriation enacted	$ 99,400
Program increases and decreases:	
Coal Coal Technology	
o P.L. 99-190 made available $99.4 million in FY 1986, $149.1 million in FY 1987, and $149.1 million in FY 1988	+49,700
FY 1987 budget request	$149,100

Coal coal technology:

Goals/Objectives:

The principal goal of this program, as stated in P.L. 99-190, is "for the purposes of conducting cost-shared clean coal technology projects for the construction and operation of facilities to demonstrate the feasibility of future commerical operation." It is targeted at the wide variety of emerging clean coal technologies located in the U.S., and using U.S. coals in a wide variety of market applications.

In FY 1986, in response to P.L. 99-190, the Department issued a competitive solicitation requesting proposals for cost-shared clean coal technology demonstration projects and selected projects for cooperative agreement negotiations. In FY 1987, DOE will complete the cooperative agreement negotiations and work called for under the agreements will be initiated.

FY 1986 Accomplishments:

- o Issue a competitive solicitation requesting proposals for clean coal technology demonstration projects.
- o Select projects for cooperative agreement negotiations.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Cooperative agreements	$97,909	$147,112	$+49,203

FY 1987 funding for cooperative agreements would support, on a cost-shared basis with the private sector, demonstration of advanced technologies to gather the data needed for their ultimate commercialization. Successful demonstration and commercial application of clean coal technologies could result in increased coal utilization and make coal a more desirable fuel in markets now dominated by oil and gas.

To accomplish these goals, the Department will issue a competitive solicitation for Federal assistance to the private sector that are applicable to the broad array of coal-based emerging clean coal technology systems for use in all energy market applications. After evaluating all submitted proposals, the Department would then enter into cost-shared cooperative agreements with the private sector to demonstrate the selected systems.

Program direction	$ 1,491	$ 1,988	$ +497

In order to implement and execute the Clean Coal Technology Program, the Department has been given the authority to charge certain costs related to program direction against appropriations for this program. These costs represent primarily travel and contracted technical support related to the pre-award proposal evaluation phase and the post-award monitoring and data base activities.

The FY 1987 funding for program direction will provide for contractual services and in-house support in performing post-award monitoring and technical data base activities. These activities would include attendance at project review meetings and the collection, processing and dissemination of technical data.

In addition, funding is provided to cover travel costs of Energy Technology Centers and Headquarters personnel associated with post-award monitoring activities.

DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

VOLUME 6

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- Enhanced Oil Recovery 107
- Oil Shale 115

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DEPARTMENT OF ENERGY

Proposed Appropriation Language

Fossil Energy Research and Development

(Including Transfer of Funds)

For necessary expenses in carrying out fossil energy research and development activities, under the authority of the Department of Energy Organization Act (Public Law 95-91), including the acquisition of interest, including defeasible and equitable interests in any real property or any facility or for plant or facility acquisition or expansion, [$312,848,000] $82,767,000, to remain available until expended, of which [$535,000] $221,000 is for the functions of the Office of the Federal Inspector for the Alaska Natural Gas Transportation System established pursuant to the authority of Public Law 94-586 (90 Stat. 2908-2909), and [$8,230,000 to be derived by transfer from unobligated balances in the "Fossil energy construction" account, $2,010,000 to be derived by transfer from the account entitled "Alternative fuels production", of which $200,000 is derived from Public Law 98-146 for a wood pellet gasifier facility, and $2,775,000] in addition, $437,000 to be derived by transfer from amounts derived from fees for guarantees of obligations collected pursuant to section 19 of the Federal Nonnuclear Energy Research and Development Act of 1974, as amended (42 U.S.C. 5919), and deposited in the "Energy security reserve" established by Public Law 96-126: Provided, That no part of the sum herein made available shall be used for the field testing of nuclear explosives in the recovery of oil and gas: Provided further, That notwithstanding any other provision of law, funds [appropriated] available under this head in Public Law [97-394 for a Western Hemisphere alternative fuels facility feasibility study, which remain unobligated,] 99-190 for implementation of the June 1984 multiyear, cost-shared magneto-hydrodynamics program shall be available for carrying out any fossil energy research and development activities[: Provided further, That $15,000,000 of the sum provided under this heading shall be available for demonstration of the Kilngas coal gasification process, with the provision that the United States Treasury shall be repaid up to double the total Federal expenditure for such process from proceeds to the participants from the commercial sale, lease, manufacture, or use of such process].

[Of the funds herein provided, $29,000,000 is for implementation of the June, 1984 multiyear, cost-shared magneto-hydrodynamics program targeted on proof-of-concept testing: Provided further, That 10 per centum private sector cash or in-kind contributions shall be required for obligations incurred in fiscal year 1986, 20 per centum private sector cash or in-kind contributions shall be required for obligations in fiscal year 1987, and for each subsequent fiscal year's obligations private sector contributions shall increase by 5 per centum over the life of the proof-of-concept plan: Provided further, That existing facilities, equipment, and supplies, or previously expended research or development funds are not cost-sharing for the purposed of this appropriation, except as amortized, depreciated, or expensed in normal business practice: Provided further, That cost-sharing shall not be required for the costs of constructing or operating government-owned facilities or for the costs of Government organizations, National Laboratories, or universities and such costs shall not be used in calculating the required percentage for private sector contributions: Provided further, That private sector contribution percentages need not be met on each contract but must be met in total for each fiscal year.] (Department of the Interior and Related Agencies Appropriations Act, 1986, as included in Public Law 99-190.)

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
AMOUNTS AVAILABLE FOR OBLIGATION
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(In thousands of dollars)

	FY 1986	FY 1987
Appropriation:		
Definite	$310,971	$ 82,767
Sequestration of Funds Pursuant to Gramm, Rudman, Hollings Bill	-14,017	...
Permanent Authority	15,000	...
Appropriation Total	$311,954	$ 82,767
Unobligated Balances:		
Start of year unobligated balances	$ 56,904	$ 67,948
Unobligated balances transferred to other appropriations	...	...
Unobligated balances transferred from other appropriations	4,785	437
End of year unobligated balances	-67,948	-1,062
Recovery of prior year obligations	6,000	...
Total Obligations	$311,695	$150,090

DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATION BY MAJOR ACTIVITY

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

(Budget Authority in Thousands of Dollars)

	FY 1985 Actual	FY 1986 Estimate	FY 1987 Request
COAL:			
Control Technology and Coal Preparation	$ 34,791	$ 31,950	$ 18,147
Advanced Research and Technology Development	30,804	33,849	27,224
Coal Liquefaction	31,110	31,620	9,147
Combustion Systems	30,092	29,113	9,169
Fuel Cells	40,472	34,057	5,000
Heat Engines and Heat Recovery	11,850	12,314	7,942
Underground Coal Gasification	5,705	4,072	---
Magnetohydrodynamics	30,721	27,717	---
Surface Coal Gasification	35,134	41,323	5,598
Subtotal, Coal	250,679	246,015	82,227
PETROLEUM:			
Advanced Process Technology	5,364	5,523	1,811
Enhanced Oil Recovery	11,702	11,454	4,484
Oil Shale	14,628	12,136	3,595
Subtotal, Petroleum	31,694	29,113	9,890
GAS:			
Unconventional Gas Recovery	10,142	8,503	5,252
Subtotal, Gas	10,142	8,503	5,252
POLICY AND MANAGEMENT:			
Headquarters Program Direction	8,273	13,380	11,260
ETC Program Direction	37,907	39,265	28,740
Federal Inspector for the Alaska Gas Pipeline	1,401	511	221
Capital Equipment	4,425	2,865	---
Construction	4,916	3,332	---
Subtotal, Policy and Management	56,922	59,353	40,221
COOPERATIVE VENTURE R&D POOLS	---	---	12,500
Subtotal, Fossil Energy	349,437	342,984	150,090
Use of Prior Year Balances and Other Adjustments	-60,389	-31,030	-67,323
Total, Fossil Energy R&D	$289,048	$311,954	$ 82,767

Department of Energy
FY 1987 CONGRESSIONAL BUDGET
MAJOR ACTIVITY OVERVIEW

Fossil Energy

PRINCIPAL ISSUES IN FOSSIL ENERGY BETWEEN NOW AND 2000

Fossil fuels -- oil, natural gas and coal -- accounted for 90 percent of the energy consumed in the United States during 1984, and will supply the majority of the Nation's energy needs well into the next century. Availability of these fuels is thus a major component of the national energy policy.

The resources to supply various fossil fuels domestically have shifted significantly during this century, and will continue to change in the future. At first, wood and then coal were the dominant fuels used during the early phases in the development of modern industrialized societies. The major growth in energy demand has occurred during a period of relatively plentiful and inexpensive supplies of oil and natural gas -- a trend which began in the mid-1920's. As a result, both the economies of the developed countries and the economic aspirations of many lesser developed countries are based upon energy production and utilization technologies (and their associated highly sophisticated, manufacturing and distribution infrastructures) to which these premium[1] fossil fuels are essential. Currently, oil and gas account for approximately 65 percent of both free world and U.S. energy consumption. From the perspective of relative resource abundance, this fuel-use pattern is imbalanced. Coal, accounting for over 80 percent of the estimated U.S. recoverable fossil reserves, contributes only some 23 percent of the energy consumption. Oil, the least abundant (and most critical) resource, constituting about 3 percent of U.S. estimated recoverable fossil fuel reserves, accounts for over 42 percent of consumption. If the vast U.S. oil shale and peat resources are included, the imbalance becomes even more pronounced.

The imbalance between the consumption/resource ratio for conventionally produced gas and particularly oil versus that for other far more abundant domestic fuels could have potentially adverse future implications for U.S. energy stability and security. This is reflected in projections done for the U.S. Energy Information Administration's Annual Energy Outlook (published January 1985), which show gross oil imports exceeding 50 percent of domestic liquid needs by 1995 due to the projected availability of moderately priced imports. In spite of this, there are a number of sound business/economic reasons why industry is unlikely to make a rapid transition in fuel-use patterns.

- There are major fuel-consuming sectors (e.g., transportation, industrial process heat applications and small industrial and commercial boilers), where practical technologies for the direct utilization of coal, electricity or renewables have not yet evolved.

- The capital investment currently in place for fuel-specific energy production and utilization equipment is large. The payback period to recover the investment in new capacity is long compared to the frequency of unanticipated (and historically realized) and significant changes in oil prices, market conditions, and environmental concerns. Thus, even if conditions look favorable at a particular point in time for investing in new capacity, there is uncertainty as to whether such conditions will continue to persist.

1/ "Premium" refers to gaseous and liquid fuels, particularly liquids, that command a relatively higher price because of their convenience of use.

- The front-end capital components of energy costs associated with coal, oil shale, tar sands and other unconventional fossil energy resources are significantly higher than those associated with the intensively utilized conventional liquid and gas resources, and the lead times required for system planning and construction are longer, thus increasing overall risks related to future uncertainties.

- The inherent potential for unacceptable environmental impacts (and attendant costs) associated with certain abundant fossil resources, such as coal and oil shale, is relatively high.

The potentially slow pace of the shift away from heavy reliance on conventional sources of premium fuels is reflected in projections made for the National Energy Policy Plan (NEPP), which for the year 2010 indicate oil and gas will supply between 44 and 49 percent of total U.S. primary energy consumption (all fuels), with imports representing from 39 to 41 percent of oil and gas consumption. A number of uncertainties exist, however, that make it difficult to estimate the pace of this shift, including: future price and availability of oil and gas from conventional resources (as illustrated by current reversal in world oil price trends); environmental performance requirements; technical, economic and environmental performance of new fossil and other competing technologies; future demand for different fuels; and other market parameters which may change significantly during the life of an investment.

Electricity is an important intermediate activity on the spectrum between energy producer and energy consumer. Electric power generation consumes about 35 percent of the primary energy used in the United States. About 28 percent of the fossil energy used and 82 percent of the coal used is for electricity generation. Current DOE estimates indicate that electricity demand growth is likely to increase at an annual rate of 2.5 percent over the period 1984-2000. Since other end-use fuel demand is projected to increase at a much slower rate than electricity growth, the electricity share of final energy consumption is projected to increase during the remainder of this century.

Availability of an adequate supply of electricity at reasonable costs to meet current and future needs has come to be viewed as a "right" by many consumers. Although sufficient electricity supplies should be available throughout the 1980's, the long-term outlook for continued availability of reliable supplies at reasonable costs is not certain.

NEPP projects that significant additional generating capacity will be required to meet future demands, to replace obsolete facilities, to displace high cost fuels (oil and natural gas) and to provide for effective reserve margins. Based upon NEPP projections, coal use for electricity generation by the year 2000 could amount to 23 percent of total primary energy use. That would account for 84 percent of total coal used domestically. All of this is projected to occur at the same time that environmental questions about coal mining and use continue to be of serious public concern. In terms of tonnages, consumption of coal to generate electricity is expected to grow from the present 664 million tons annually to some 1,059 million tons in the year 2000 - a 60 percent increase in 16 years. If coal is going to attain projected use levels for generating electricity, it is essential that improved technologies be developed to allow the use of coal in both new and existing power plants in an economically competitive and environmentally acceptable manner.

ROLE OF DOE'S FOSSIL ENERGY PROGRAMS

While the Nation is fortunate to have abundant fossil energy resources, diverse and extensive advances are needed in the scientific and engineering knowledge base in order to achieve an effective utilization balance in the long term. Systematic technical advances must occur in all stages of the research, development, and commercialization cycle. To a large extent, this cycle can be described in terms of the path taken by technology development and the stages through which new technologies pass until they

reach the market as competitive energy investment options. Stated simply, the technology development path consists of five stages. Basic research seeks to develop fundamental scientific knowledge, including a fundamental understanding of the physical and chemical properties of unconventional fuel sources or energy systems, leading to the definition of new energy R&D concepts. Applied research includes activities to resolve broad engineering and physical science problems in specific fossil technologies and related areas. However, practical utility may not be proven at this stage. Proof-of-concept is where enough has been learned to resolve specific problems to determine the technical and environmental feasibility of the integrated process. Data are generated to evaluate critical scale-up parameters, characterize sub-systems, processes, and products, and to permit preliminary economic projections to be made. Process development is directed at increasingly larger scale engineering design, construction and operation of energy systems with the objective of reducing technical risks and improving the process operability, reliability, economics, and environmental impact. Commercialization consists of a wide variety of efforts to eliminate technical, economic and institutional barriers required for acceptance of a new energy technology into the marketplace.

The latter stages of this cycle are the most costly but the risks are also the most defined and predictable. This is where private sector responsibilities take over to move advanced technologies into commercial reality. The earlier stages (i.e., basic research through proof-of-concept), feed this research and development (R&D) investment pipeline with the results of long-term, high-risk, and potentially high- payoff research. While R&D in these earlier stages may have a very high benefit/cost ratio from the public perspective, private sector investment may be restricted because payoffs are frequently difficult to predict, highly risky or would require an exceptionally long time to be recognized, or cannot be captured by individual firms.

Thus, there are reasons why it may be desirable for the government to undertake certain energy activities including energy conservation programs and, to encourage development of abundant and presently uneconomical or technically difficult domestic resources so that these resources will be more attractive to the marketplace. This includes providing federal funding assistance for early stages of the R&D cycle for the development of new technologies; for R&D to remove environmental uncertainties, and to make resources under federal control available at a fair price; and other actions that do not introduce inefficiencies through inappropriate intervention in the marketplace.

Fossil Energy Strategic Objectives

As discussed in the NEPP, the Administration's goal in energy policy continues to be that Americans should have an adequate supply of energy, maintained at a reasonable cost. This goal presupposes three broad conceptual objectives: energy stability, energy security and energy strength.

Energy stability means a situation in which problems of energy availability and price no longer destablize the U.S. economy and our way of life. Energy security means that adequate supplies of energy are physically available to U.S. consumers from both domestic and foreign souces, and that we are less vulnerable to disruptions in energy supply and better prepared to handle them if they should occur. Energy security leads to energy strength, whereby it is possible to effectively exploit the vast energy resource base of the United States. New supply and utilization technology can contribute to all of these objectives, particularly energy strength.

Implicit in achieving the national goal and objectives described above are the following strategies:

- Minimize federal control and involvement in energy markets while maintaining public health and safety and environmental quality.

- Promote a balanced and diversified energy resource system.

In addition to NEPP, Administration policy and guidance, DOE mission statements, Congressional guidance and analyses of fossil fuel supply and utilization trends and issues provide the framework within which the Office of Fossil Energy R&D program has been developed. Included in this framework are the strategic objectives which follow, and, in effect, provide an indication of how FE programs are addressing the issues outlined earlier.

Recognizing the need to effect an orderly transition to greater utilization of the most abundant domestic fossil fuel resources, two complementary overall strategic objectives have been established for FE:

1. Increase the contribution of coal by improvements in environmental, technical, and economic performance and increase the number of areas of application and flexibility of use of coal-based systems.

2. Increase the effective resource base for premium gas and liquid fuels through enhanced resource recovery and/or production of liquid and gaseous fuel analogs from coal, shale, and tar sands.

The FE program pursues these strategic objectives through activities which identify research opportunities and conduct research (and transfer the results of such research to the user community) in the extraction, processing, and utilization of domestic fossil fuel resources which are not being pursued by the private sector because of high-risk/long-term characteristics. This research should offer substantial potential improvements in terms of enhanced liquid and gaseous fuel supply or reduced demand and/or improved efficiency, economics, or environmental protection. FE plans, coordinates, and carries out research to the extent necessary to establish proof-of-concept and to provide the essential information for the private sector to make process development and commercial plant deployment decisions.

Crosscutting R&D Objectives

There are two strategic objectives that cut across all of the fossil fuel R&D programs. One is that process/technology research will be coupled with the appropriate associated environmental research to economically manage environmental impacts of processing and using fossil fuels. This includes work needed to establish data bases that help mitigate problems rather than merely expand the range of questions and concerns. Energy and environmental objectives may appear to conflict more frequently than converge, but they are not mutually exclusive. The question is not one of "either/or," rather, it is a matter of determining how to achieve a proper balance between technology issues (such as resource recovery, process efficiency, etc.) and environmental intrusions. The objective of this research is to characterize potential impacts and the performance of new and developmental systems in controlling these impacts so that more efficient solutions to environmental concerns are available on a schedule consistent with the development of advanced technology.

The second objective is that all process/technology research will be coupled to advanced research activities needed to improve the understanding of fundamental scientific and engineering mechanisms. Such understanding is critical to effectively assessing the ways fossil resources can be utilized, and provides the basis for new ideas to lead to future major innovations in fossil fuel technologies. These activities are directed toward the advancement of those scientific and technical disciplines that underlie the development of all Fossil Energy technologies. They include fundamental research on physical, chemical and thermodynamic characteristics of fossil fuels and their derivatives, fluid phenomena, solids transport, multiphase flow, combustion, materials, instrumentation and analytical techniques, environmental sciences, geosciences, innovative concepts, coordination of international activities in Fossil Energy, and sponsoring long-term scientific coal research at universities.

Program Objectives

There are a number of program objectives listed below that apply to the research and development in Fossil Energy.

Coal:

- Foster development of economic methods for modifying the overall physical characteristics of coal (reduce ash and sulfur, but do not change state) to permit the resultant cleaned/modified coal to be used dry or as a slurry to permit utilization in a number of combustion systems.

- Identify and foster development of new processes and/or equipment that are capable of using coal directly or as modified fuel forms in such a way as to increase the efficiency in the use of the fuel, extend its applicability and/or allow for its substitution for oil or gas.

- Foster development of lower cost more environmentally-acceptable technologies for the generation of electricity from coal which can increase the flexibility of the utility industry to meet capacity expansion and replacement needs.

- Identify and foster development of new, useful and environmentally acceptable approaches for managing coal cleaning waste, ash, and other waste product disposal.

- Foster development of improved and more economic and environmentally acceptable technologies to allow coal to be converted (including both above ground and underground processes) into a gaseous fuel or synthesis gas suitable for the requirements of new as well as existing end uses.

- Foster development of economically attractive and environmentally acceptable technologies to allow coal to be converted (including both direct and indirect liquefaction) to a complete range of petroleum substitutes that can be used for transportation, industrial, utility, and chemical applications.

- Identify and foster development of new fuel forms that can be produced from coal (other than those cited above) as an energy source in existing or new energy conversion systems.

Oil:

- Foster development of economically attractive and environmentally acceptable technologies for (1) enhanced light oil recovery, (2) in situ thermal recovery of heavy oil and tar sand bitumen, and (3) conversion of oil shale, all of which can add to the supplies of oil from conventional sources.

Gas:

- Foster development of unconventional and novel natural gas resources which can add to the supplies of natural gas from conventional sources.

While these objectives provide the framework for most FE R&D activities, it should be noted that there are other activities that are performed within the context of the national energy goal and strategies. These activities, which reside in FE because of its management and technical experience/expertise include: general policy and strategic studies related to fossil energy; studies and analysis on fossil fuel transportation issues and certain energy supply aspects of leasing; management of the Liquefied Gaseous Fuels Spill Test Facility program to address safety issues associated with large spills; and support to federal agencies on fossil energy related matters.

Program Guidelines

In addition to the above program objectives, there are a number of guidelines and criteria that are observed in the planning and execution of FE programs. Two of the most prominent include private sector participation and international cooperation. Regarding the former, private sector input is solicited during the program planning process through a variety of mechanisms, including advisory groups, workshops and peer reviews. In the program execution phase, substantial emphasis is placed on cost-sharing to facilitate the transfer of technology to the private sector and to reduce federal expenditures. Inherent in this approach is an attempt to attract research performers that have a long-term institutional commitment to an area of research and to the ultimate application of the research results. In general, industry will be more willing to invest its money in potential high payoff R&D as risks and uncertainties are reduced, and thus cost-sharing frequently becomes more attractive as R&D approaches the proof-of-concept stage.

One of the primary goals of all the applied research areas in FE is to effectively transfer technology from Federal and university laboratories to private industry. The earlier industry is involved, and the more directly that the research agenda is guided by the companies' own economic self-interest, the more effective the transfer is likely to be. In FY 1987, Fossil Energy will "pilot-test" a special case of this cost-sharing approach known as cooperative ventures. The approach will be to solicit proposals from the private sector in a broad area of applied research, where two or more firms would propose to form a "pre-competitive" cooperative venture with DOE. It is DOE's intent to impose minimal constraints on potential proposals and to select on the basis of technical and financial merit among all proposals regardless of the specific areas proposed for further R&D. Resultant royalties or other profits would be shared proportionately by the participants. To the extent that industry is willing to enter into such ventures, benefits could result such as better leveraging of scarce Federal funds and aiding technology transfer by increasing the number of private sector participants.

Many of the same factors that make participation with the U.S. private sector desirable have motivated FE to seek international cooperative efforts. There is additional interest in that the U.S. Government is actively seeking to facilitate the long-term reduction of U.S. and international dependence on oil by supporting research that could lead to the development and substitution of other energy forms. The overriding concern is that any cooperative efforts must support FE program objectives.

FOSSIL ENERGY PROGRAM BUDGET

The levels of federal support in the budget for the various Fossil Energy technologies are believed to be appropriate given the need to progressively reduce Federal budget deficits, and when compared to the needs and to the levels of federal funding both for other energy related technologies and for other governmental activities.

DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

COAL

VOLUME 6

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DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 1/ Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Control technology and coal preparation (FE)					
Coal preparation:					
Operating expenses	$10,965	$12,716	$12,716	$ 6,443	$ -6,273
Subtotal	10,965	12,716	12,716	6,443	-6,273
Flue gas cleanup:					
Operating expenses	14,511	10,952	10,952	7,541	-3,411
Subtotal	14,511	10,952	10,952	7,541	-3,411
Gas stream cleanup:					
Operating expenses	7,348	7,105	7,105	3,839	-3,266
Subtotal	7,348	7,105	7,105	3,839	-3,266
Waste management:					
Operating expenses	1,967	1,177	1,177	324	-853
Subtotal	1,967	1,177	1,177	324	-853
Total					
Operating expenses	34,791	31,950	31,950	18,147	-13,803
Control technology and coal preparation	$34,791	$31,950	$31,950	$18,147	$-13,803
Staffing Total FTE's: Direct	54	55	55	45	-10
Indirect	30	28	28	22	-6

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Control Technology and Coal Preparation (FE)				
Coal Preparation Operating Expenses	$13,305	$-69	$-520	$12,716
Flue Gas Cleanup Operating Expenses	11,460	-60	-448	10,952
Gas Stream Cleanup Operating Expenses	7,433	-38	-290	7,105
Waste Management Operating Expenses	1,232	-7	-48	1,177
Subtotal, Control Technology and Coal Preparation	$33,430	$-174	$-1,306	$31,950
General Reduction: Operating Expenses	-174	174	-	-
Total, Control Technology and Coal Preparation	$33,256	-	$-1,306	$31,950
Operating Expenses	33,256	-	-1,306	31,950

Summary of Changes

FY 1986 Appropriation enacted	$31,950
Program increases and decreases:	
Coal Preparation	
o Research efforts will be completed and not continued into FY 1987 in the areas of low rank coal hot water drying, ultrasonic comminution, fine coal dewatering, and contracted efforts in the development of advanced physical coal cleaning concepts. Technology base activities will be continued in the areas of Gravimelt development, chemically modified coals, microbial desulfurization, joint DOE/EPRI development and test, ultrafine coal characterization, and in-house research on chemical coal cleaning, physical coal cleaning and organic sulfur chemistry	-6,273
Flue Gas Cleanup	
o Complete activities on electron beam processess, pressure hydrated lime furnace sorbent injection, fine particulate control and dry scrubber SO_x/NO_x process	-3,411
Gas Stream Cleanup	
o Complete subpilot testing of PFBC particulate removal devices and zinc ferrite sorbent testing at subpilot scale; terminate tests of second generation PFBC particulate removal devices; continue contaminant control base activities	-3,266
Waste Management	
o Complete several ongoing Waste Management activities and continue technology base activities which include sampling and characterization of organic and inorganic species in solid wastes produced by emerging technologies, and energy recovery from coal preparation wastes	-853
FY 1987 budget request	$18,147

Control technology and coal preparation:

Goals/Objectives:

Economic and social barriers to a rapid, widespread replacement of oil by coal derive mainly from quality differences. The inert matter in even our best coals imposes cost penalties in transportation and utilization. Additional costs are incurred in burning most U.S. coals because of the considerable sulfur or nature of the mineral constituents or trace elements they contain. This added cost burden results from specific requirements for environmental management, waste disposal, combustor design modifications, and ancillary equipment capacity. In summary, the ultimate cost of electricity, process heat, or shaft horsepower is strongly dependent on technologies dealing with coal quality, environmental emissions, and waste disposal. In-depth research for interdependent technologies of coal beneficiation, gas cleaning, and waste disposal is essential to critical economic and engineering analyses of site-specific coal utilization requirements. This, in turn, is necessary to achieve the highest degree of cost effectiveness in the expanded utilization of U.S. coals. The goals of the Control Technology and Coal Preparation activity are to identify and develop a range of advanced engineering approaches capable of:

- Upgrading the quality of U.S. coals to quality levels that will allow coal-based fuels to penetrate those markets now being supplied by liquid fuels in an economically sound and environmentally acceptable manner.
- Improving the ability to remove flue gas pollutants for compliance with emission standards.

- o Developing a capability to reduce the emissions of suspected acid rain precursors from existing, uncontrolled coal-fired boilers that is significantly lower in cost than commercially available methods.
- o Removing undesirable substances produced during gasification and/or combustion from process streams, thus protecting utilization equipment such as turbines and fuel cells.
- o Providing waste disposal technologies that will permit compliance with environmental pollution regulations without excessive costs.

The functional organization of this activity forms four logical subactivities: (1) Coal preparation; (2) Flue gas cleanup; (3) Gas stream cleanup; and (4) Waste management.

Coal preparation is directed toward the development of advanced coal cleaning technologies that will reduce the ash and sulfur content of U.S. coals so that the product can be formulated into a high quality fuel that could replace oil and/or gas and reduce environmental emissions of suspected acid rain precursors from coal-fired power plants in both new and retrofit applications. Flue gas cleanup addresses the removal of pollution causing contaminants from the stack gases of conventional combustion units to meet environmental standards. Efforts will be focused on fundamental research for processes for the combined removal of NO_x, SO_x, and particulates, both for utility and industrial applications. Gas stream cleanup includes the technology for removal of contaminants from gasifier and combustor process streams prior to utilization in advanced power conversion cycles such as gas turbines and fuel cells. Both hardware and environmental protection are key concerns. Waste management focuses primarily on waste sampling and characterization from coal preparation wastes.

FY 1986 Accomplishments:

Major accomplishments expected in FY 1986 include:

Coal Preparation

- o Completed development of low-rank coal hot-water drying process and investigation of low-rank fine coal cleaning.
- o Completed testing of Gravimelt and microwave chemical coal cleaning reactors at 20 lb/hr scale.
- o Issued PRDA to identify and investigate advanced concepts for chemically modified coals.
- o Continued development of advanced physical coal cleaning processes including joint DOE/EPRI test at EPRI Coal Cleaning Test Facility.
- o Continued research on microbial removal of organic sulfur from coal.
- o Completed coal preparation research activities at Southern Illinois University.
- o Completed research on coal characterization, chemical cleaning, physical cleaning and ancillary operations at Ames National Laboratory.
- o Completed research on microbubble flotation technology advanced concepts.
- o Completed efforts on ultrasonic comminution and fine coal dewatering.
- o Continued research on the chemical and physical characterization of ultra-fine coal.
- o Continued research on the beneficiation of chemically modified coals and advanced concepts for chemical coal cleaning.
- o Continued research on advanced physical coal cleaning concepts such as selective agglomeration, ultrafine coal flotation, electrostatically enhanced magnetic separation and true heavy liquid cycloning.

Flue Gas Cleanup

- o Completed bench scale evaluation of electron beam charging and acoustic agglomeration techniques for fine particulate control.
- o Continued proof-of-concept test and evaluation of candidate acid rain control technology processes.
- o Completed sorbent development for boiler injection applications for SO_2 control.
- o Completed proof-of-concept test and evaluation of the electron beam/ammonia simultaneous NO_x/SO_x cleanup process.

- Continued proof-of-concept test and evaluation of the fluidized bed copper oxide simultaneous NO_x/SO_x cleanup process.
- Continued research on advanced NO_x/SO_x chemistry and thermodynamics, and bench scale development of advanced NO_x/SO_x cleanup processes.
- Completed research on potential process modifications for achieving combined NO_x/SO_x control (dry scrubber process).
- Completed evaluation of Glo-Klen catalyst.

Gas Stream Cleanup

- Terminated program definition phase for selecting cleanup devices for PFBC system integration proof-of-concept testing.
- Continued economic/systems analysis for PFBC alkali metals and particulate removal devices and desulfurization processes to determine their future potential.
- Completed the testing of the zinc ferrite desulfurization process on a fluidized bed gasifier.
- Continued investigations into process modification control methods for ammonia, aromatic hydrocarbons, and tar cracking.
- Continued on-line coal gasification tests for selected high temperature, high pressure sulfur removal processes for gasifier/turbine combined cycle application.
- Conducted bench scale testing of novel high temperature and pressure desulfurization processes using gasification produced fuel gas.
- Completed research on control and removal of trace contaminants of arsine, aromatic hydrocarbons, and hydrogen chloride to molten carbonate fuel cells.
- Initiated preliminary experimental research of novel processes to treat regeneration tail gases from high temperature desulfurization of coal gases.
- Continued test and evaluation of soot and particulate control in coal fuel gas to molten carbonate fuel cells.
- Completed PFBC subpilot testing of ceramic cross flow filter and screenless granular bed filter.
- Completed coal gasification bench scale testing of ceramic bag filter and electrostatic precipitator.
- Completed laboratory investigation of acoustic agglomeration, a second generation particle control concept.
- Completed investigation of boundary layer turbulence in cyclone separators to establish its form, impact on particle collection and possible methods of suppression.
- Initiated direct coal fired turbine studies PRDA.
- Continued research on specific instrumentation problems; investigation of chemical and physical properties of contaminants.
- Determined concept feasibility of SO_2 removal with selected sorbents.

Waste Management

- Continued sampling and characterization of organic and inorganic species in solid wastes produced by emerging coal use technologies.
- Completed initial phase of waste management laboratory analyses of coal wastes.
- Continued adsorption and degradation studies of polyaromatic hydrocarbons (PAH's) compounds in soil.
- Continued field study initiated during last quarter of FY 1985 with identification and establishment of multi-sites for monitoring leachate and behavior of solid wastes under actual field conditions.
- Continued R&D for extracting energy from coal preparation wastes.
- Continued MIS data base activity.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Coal preparation	$12,716	$ 6,443	$ -6,273

The goal of the coal preparation program is to develop coal cleaning technology to reduce the ash and sulfur content of U.S. coals so that the product can be formulated

into a high quality fuel that could replace oil and/or natural gas and reduce environmental emissions in both new and retrofit applications in utility boilers, industrial boilers and process heaters, residential/commercial boilers and furnaces, and heat engines such as gas turbines and diesel engines.

Research efforts will be completed and not continued into FY 1987 in the areas of low rank coal hot water drying, ultrasonic comminution, fine coal dewatering, and contracted efforts in the development of advanced physical coal cleaning concepts.

Most coals resist cleaning by conventional practices either because the ash and sulfur constituents are too finely dispersed in the coal structure or because the organic sulfur content, which does not respond to physical cleaning, is too high. The principal thrust of the coal preparation program is thus directed toward:

- o New and advanced cost-effective technologies to clean and condition finely comminuted (ground) coal as necessary to liberate finely dispersed pyritic sulfur and ash particles.
- o Advanced experimental methods to extract organic sulfur from coal.

The program encompasses laboratory research efforts focused on the removal of finely dispersed mineral matter impurities, pyritic sulfur, and organic sulfur from all coals. The program includes research on physical and chemical beneficiation techniques and supporting research such as micro-characterization. In the physical cleaning area, selective coalescence, froth flotation, and specific gravity techniques which have demonstrated the ability to remove 90 percent of the pyritic sulfur from selected coals, are being developed. Instrumentation methods such as scanning electron microscopy, image analysis, etc., are being utilized for characterizing the finely ground raw coal and cleaned products in order to develop the basic data needed in the development of the various cleaning technologies.

The cleaned coal products developed under this subactivity will become feedstock for activities in Combustion Systems and Heat Engines aimed at the conversion of existing utility and industrial units from oil or gas to coal; new units fired either conventionally or by coal slurries; direct firing of coal in power conversion equipment (e.g., gas turbines and diesels); export steam coal; and for utilization in existing coal-fired boilers as a cost-effective means of reducing emissions of suspected acid rain precursors. New equipment designs and/or conversion of existing units to coal or coal-based slurries, initiated in the late 1980's, will clearly benefit from the availability of the engineering data developed in this program.

The following major accomplishments are anticipated for FY 1987:

- o Continue work on the characterization of ultrafine coal to determine the beneficiation potentials of alternative advanced physical fine coal cleaning technologies.
- o Continue in-house research on the beneficiation of chemically modified coals, advanced concepts for chemical coal cleaning, and in-house studies of fundamental organic sulfur chemistry.
- o Continue research on advanced physical coal cleaning concepts such as: selective agglomeration, ultra-fine coal flotation, electrostatically enhanced magnetic separation and true heavy liquid cycloning.
- o Complete design of Gravimelt continuous operation chemical coal cleaning system.
- o Continue joint DOE/EPRI project to develop and test advanced physical coal cleaning concepts.
- o Continue research to develop techniques for microbial removal of organic sulfur from coal.
- o Continue investigation of advanced concepts identified in FY 1986 for chemically modified coals.

	FY 1986 Approp.	FY 1987 Request	Net Change
Flue gas cleanup	$10,952	$ 7,541	$ -3,411

This program focuses on the development of technology for cost-effective, and environmentally superior processes that remove pollutants from coal combustion gas streams in both utility and industrial boilers. Its intent is to help assure that existing and projected utilization of the nation's most abundant energy resource, coal, can continue without adverse environmental effects.

The FY 1987 program reflects completion in FY 1986 of research and development activities in a number of technology areas including electron beam based processes, pressure hydrated line furnace sorbent injection, fine particulate control technology, and the dry scrubber SO_x/NO_x control process.

The primary pollutants of concern as regulated and identified in the New Source Performance Standards (NSPS), consist of sulfur oxides (SO_x), nitrogen oxides (NO_x), and particulates. SO_x are formed in the combustion process as the result of the oxidation of sulfides contained in the mineral portion of the coal as well as the oxidation of organically bound sulfur. Most of the sulfur is oxidized to sulfur dioxide (SO_2) with a small percentage oxidized to sulfur trioxide (SO_3). Nitric oxide (NO) is formed during the combustion process from the reaction of molecular nitrogen and oxygen in the combustion air (thermal NO) and from the oxidation of nitrogen compounds in the coal (fuel bound NO). While essentially 100 percent of the nitrogen oxide consists of NO, it is reported as NO_x because the EPA standard was written as the nitrogen dioxide (NO_2) equivalent of all nitrogen oxides. Particulates result from the ash content of the coal.

Existing flue gas desulfurization technology is capable of meeting sulfur removal requirements but is very costly and in many cases merely converts an air pollution problem to a solid waste disposal problem in the form of difficult-to-handle sludges, the disposition of which measurably adds to overall environmental control costs. Combustion modification can control NO_x emissions to existing standards. If these standards were to be tightened, however, an additional process would have to be added. Based on available technology, this process would most likely involve a gaseous phase NO destruction technique by reaction with ammonia in the presence of a catalyst. The addition of a process of this type for NO control would measurably contribute to the cost and complexity of the overall environmental control system. Therefore, the primary emphasis of the flue gas cleanup program has been placed on approaches to attain these high levels of SO_2 and NO control in a more cost effective manner, namely through the development of processes with the potential to remove both pollutants simultaneously in a one process step. In order to avoid the problems and costs associated with the handling and disposal of scrubber sludges, primary consideration will be given to those processes that generate relatively benign or possibly useable or marketable waste products.

In addition to the technology being developed for application to new construction under existing stringent requirements, there is a need for the development of low cost, retrofittable technology for the control of acid rain precursor emissions from existing plants. Total replacement of existing plants, with new plants meeting NSPS, is not expected until at least the year 2020. Currently available options for SO_2 control consist primarily of conventional physical coal cleaning, fuel switching, and wet and dry scrubbing. Each has associated advantages and disadvantages. Conventional coal cleaning is already in fairly wide practice where it is presently economical to do so. Capability, to significantly reduce the sulfur content of coals by conventional coal preparation, however, is limited since only some of the inorganic sulfur contained in the mineral portion of the coal can be removed. Switching to low sulfur coals is likely to severely impact the high sulfur coal industry, increase fuel costs due to greater demand as well as higher transportation costs, and cause plant derating unless

substantial plant modifications are undertaken to accommodate the different properties characteristic of low sulfur coal. Wet and dry scrubbers are effective (in excess of 90 percent SO_2 control), but are relatively expensive to purchase and operate. Reliability and availability have been problem areas as well as waste handling and disposal. Therefore, development of a low cost technology of relatively modest performance that is capable of being retrofitted to existing boilers would greatly enhance the capability for attaining SO_2 reductions.

The need for and justification of a Federal role in this area is clear cut. System requirements are essentially set by Government regulations. Because of the long lead-time between the initiation of research and the eventual commercialization of technology, the private sector is for the most part unwilling to pursue this type of work on their own since changing regulations can render their developments obsolete and their expenditures fruitless.

Anticipated FY 1987 accomplishments include:

- Complete proof-of-concept test and evaluation of the low temperature dry hydrate and dolomite lime slurry induct injection acid rain control technology processes.
- Continue research in advanced NO_x/SO_x chemistry and laboratory/bench scale development of advanced NO_x/SO_x cleanup processes.
- Continue proof-of-concept test and evaluation of the fluidized bed copper oxide simultaneous NOx/SOx cleanup process.

	FY 1986 Approp.	FY 1987 Request	Net Change
Gas stream cleanup	$ 7,105	$ 3,839	$ -3,266

The FY 1987 program reflects completion in FY 1986 of a number of research and development activities including subpilot testing of PFBC particulate removal devices, alkali control devices and zinc ferrite sorbent testing.

The primary objective of this program is to develop the required technology base in gas stream cleanup for applications in post combustion/utilization devices used as advanced power conversion systems including both molten carbonate fuel cells and turbines. Turbine cleanup concerns removal of contaminants from gasification fuel gases, pressurized fluidized bed combustors and direct coal-fired combustor gas streams. The high temperature, high pressure contaminant removal control technologies have direct application to fossil fuel conversion processes including oil shale mist particulate separation and methanation shift conversion (catalyst protection from poisoning, etc.). The gas streams range up to 2400°F in temperature and 500 psi in pressure and contain contaminants that, if not removed, will cause failure of the conversion cycle equipment, as well as prevent meeting the environmental emissions standards. Cleanup at an elevated temperature offers advantages of increased cycle thermal efficiency and reduced capital cost for downstream power conversion applications. Capital cost reductions are attributable to the elimination of the need for process equipment to quench and reheat the gas stream and to treat the contaminated waste water from the quenching process. Contaminants of concern are dependent upon the specific application. Energy conversion systems will have to meet NSPS requirements in terms of NO_x, SO_x and particulate emissions. Emphasis in combustion gas cleanup has been on the control of alkalies and particulates found in pressurized fluidized bed combustor (PFBC) gas streams powering gas turbine combined cycles. The PFBC has demonstrated the capability to meet NSPS with respect to NO_x and SO_x emissions. The turbines, however, are subject to corrosion, erosion, and deposition. Corrosion in PFB turbines is primarily caused by the presence of alkali surface compounds in the liquid state. Erosion results from the impact of high velocity particulate material. Deposition is caused by a buildup of fine particles on the turbine surfaces. Since the PFB gas turbine operates on sensible heat from the gas stream, it is essential that cleanup processes be accomplished at or near bed temperature. At present, there are no commercially available processes for alkali vapor

removal. The gasifier can be used as an energy source for either a gasifier/gas turbine combined cycle or a fuel cell. In addition to the alkalies and particulates previously mentioned, the gasifier gas turbine system must control NO_x precursors such as ammonia as well as sulfur compounds. For fuel cell applications the control of suflur is especially critical since tolerance to sulfur compounds is on the order of 0.1 to 1.0 parts per million to minimize sulfide formation at the nickel anode. The fuel cell also requires stringent control of other contaminants in the fuel gas stream such as chlorides and particulates.

Anticipated FY 1987 accomplishments include:

- Continue process modification control methods for ammonia.
- Continue fundamental R&D of particulate control and SO_2 control concepts for direct fired coal-fueled turbines.
- Complete particulate control tests for gasification.
- Continue instrument development (alkali and particulate - real time) to insure control of cleanup systems.
- Conduct fundamental R&D of the mechanisms of contaminant formation, interaction and removal in gas stream cleanup technology.
- Continue contaminant tests for molten carbonate fuel cells (MCFC).

	FY 1986 Approp.	FY 1987 Request	Net Change
Waste management	$ 1,177	$ 324	$ -853

The goal of the waste management program is to promote the development of waste management technologies that will permit existing and advanced fossil fuel utilization processes to achieve their respective goals for reducing oil and natural gas consumption while complying with environmental regulations without excessive costs. The Waste Management program has been directed at performing the required research and technology verification for dealing with the large quantities of solid waste products to enhance the environmental, economic, and social acceptance of the abundant coal resource as an energy source.

The FY 1987 program reflects completion in FY 1986 of several R&D projects and the continuation of the sampling and characterization of wastes from emerging technologies.

The coal fuel cycle presents a problem in that it produces a significant amount of waste. Some of these coal wastes are continually released to the environment as ash and leachate and the resulting effects are not fully understood. While the volume of residues from conventional technologies and those projected from emerging technologies pose a logistic problem, one of the most important unanswered questions centers around the degree of environmental hazard these residues represent. Research should provide answers which will aid the conventional coal consuming technologies to grow and accelerate the acceptance of new technologies. The three principal questions being addressed by the Waste Management program are:

- What, if any, are the potentially hazardous materials which are contained in and released from the wastes?;
- How are they released to the environment, or how do they occur?; and
- At what rate?

The answer to the first question will identify those wastes which may pose a hazard, but it will not be the deciding factor. The answers to the questions of how potentially harmful emissions occur, and at what rate, are the key to predicting the environmental impact of fossil energy waste disposal and developing control strategies. The principal thrust of the waste management program is directed towards:

- o Sampling and characterization and basic data
- o Energy recovery from coal preparation (cleaning) wastes.

Research into these areas will provide data for management of fossil energy wastes.

The proposed FY 1987 program will continue to build upon the waste management technology data base developed to date. Completion of the organics characterization of conventional fossil fuel combustion wastes during FY 1986 will permit limited work on sampling and characterization of the organics and inorganics of wastes from emerging fossil fuel use technologies. The sampling and characterization will continue to provide an understanding of waste characteristics and the physical, chemical and biological processes that release potentially harmful materials into the environment.

Anticipated FY 1987 accomplishments include:

- o Continuing multi-year sampling and characterization of organic and inorganic compounds present in solid wastes from advanced coal technologies.
- o Completing Phase I R&D for extracting energy from coal preparation wastes.
- o Completing absorption and degradation studies of polynuclear (PAH) compounds in the soil.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Advanced research and technology development (FE)					
Direct utilization:					
Operating expenses	$ 9,990	$11,262	$11,262	$ 9,415	$ -1,847
Subtotal	9,990	11,262	11,262	9,415	-1,847
Materials and components:					
Materials					
Operating expenses	7,733	6,899	6,899	5,860	-1,039
Components					
Operating expenses	1,452	2,735	2,735	1,593	-1,142
Subtotal	9,185	9,634	9,634	7,453	-2,181
Technology crosscut:					
Environmental activities					
Operating expenses	2,459	2,345	2,345	2,200	-145
Technical and economic analyses					
Operating expenses	2,360	2,151	2,151	2,000	-151
Technology base synthesis					
Operating expenses	885	779	779	800	+21
Instrumentation, control, and diagnostics					
Operating expenses	1,500	2,056	2,056	1,356	-700
Subtotal	7,204	7,331	7,331	6,356	-975
University coal research:					
Operating expenses	4,425	5,622	5,622	4,000	-1,622
Subtotal	4,425	5,622	5,622	4,000	-1,622
Total					
Operating expenses	30,804	33,849	33,849	27,224	-6,625
Advanced research and technology development	$30,804[2/]	$33,849	$33,849	$27,224	$ -6,625
Staffing Total FTE's: Direct	57	32	32	15	-17
Indirect	29	22	22	19	-3

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

2/ Liquefaction processes ($5.511M) and gasification processes ($3.364M) transferred from this activity to the Coal Liquefaction activity and Surface Coal Gasification activity, respectively.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Advanced Research and Technology Development (FE)				
Direct Utilization				
Operating Expenses	$11,780	$-58	$-460	$11,262
Materials and Components:				
Materials				
Operating Expenses	2,861	-14	-282	2,565
Components				
Operating Expenses	7,216	-35	-112	7,069
Subtotal	10,077	-49	-394	9,634
Technology crosscut:				
Environmental activities				
Operating Expenses	2,453	-12	-96	2,345
Technical and Economic Analyses				
Operating Expenses	2,250	-11	-88	2,151
Technology Base Synthesis				
Operating Expenses	815	-4	-32	779
Instrumentation, Control, and Diagnosis				
Operating Expenses	2,150	-10	-84	2,056
Subtotal	7,668	-37	-300	7,331
University Coal Research				
Operating Expenses	5,884	-32	-230	5,622
Subtotal, Advanced Research and Technology Development..	$35,409	$-176	$-1,384	$33,849
General Reduction:				
Operating Expenses	-176	176	-	-
Total, Advanced Research and Technology Development	$35,233	-	$-1,384	$33,849
Operating Expenses	35,233	-	-1,384	33,849

Summary of Changes

FY 1986 Appropriation enacted	$33,849
Program increases and decreases:	
Direct Utilization	
o Decrease research in: deposition mechanisms; in-situ contaminant control; atmospheric and pressurized combustion phenomena; sulfur removal processes; molten carbonate and solid oxide electrochemistry; and fundamental beneficiation mechanisms	-1,847
Materials and Components	
o Materials - Reduce research in the areas of corrosion and erosion, alloy development, and structural ceramics development and characterization	-1,039
o Components - Decrease R&D on solids transport and novel component concepts	-1,142
Subtotal	-2,181
Technology Crosscut	
o Environmental activities - Decrease in the capability to conduct independent reviews and quality control of analytical tools and data bases under the Interagency Task Force on Acid Precipitation (ITFAP) program along with a decrease in analyses associated with air quality and water quality	-145
o Technical and economic analyses - Reduction in capability to improve the quality of analytic tools and data to perform technical/economic analyses of issues associated with potential fossil fuel utilization for the industrial and utility sectors	-151
o Technology base synthesis - Continue studies to identify fossil energy-related research needs and to order research priorities. Also, continue support to develop international cooperative research programs and technology exchanges	+21
o Instrumentation, control, and diagnostics - Reduce support for development of new measurement and control techniques to measure chemical and physical properties of process streams	-700
Subtotal	-975
University Coal Research	
o Decrease to about 20 the number of new university coal research projects relating to coal science, environmental science, surface science, organic and inorganic chemistry of coal constituents, and the mechanisms and kinetics of chemical reactions important to gasification, liquefaction and combustion	-1,622
FY 1987 budget request	$27,224

Advanced research and technology development:

Goals/Objectives:

The Advanced Research and Technology Development (AR&TD) Program is directed toward the scientific and technical areas that underlie the development of all fossil energy technologies. The program has been reoriented to respond to the critical fundamental research needs identified in recent years by the Energy Research Advisory Board, various Fossil Energy Research Working Groups, the National Academy of Sciences, and others. To assure continuation of the high quality research, program relevance, and scientific merit, a peer review of the AR&TD program was conducted in early 1984. The review was coordinated by DOE's Office of Energy Research and involved project assessments by experts from industry, National Laboratories, and academia.

The AR&TD coal science program focuses on mission-oriented fundamental research to increase understanding of the mechanisms of direct coal combustion. The AR&TD program also includes generic studies of materials and components and investigations of instrumentation concepts in environments associated with advanced coal technologies. Fundamental research at the Energy Technology Centers, National Laboratories, universities, and industrial and not-for-profit laboratories helps extend the scientific and engineering knowledge base and provides ideas for new processes and possible technical breakthroughs in coal conversion and utilization.

An important goal in each AR&TD subprogram is the discovery of new concepts and the small scale testing of these concepts for scientific and technical feasibility. AR&TD differs from the Fossil Energy line programs; the latter have an end-item technology development orientation. The AR&TD mission is to pursue generic research in support of all Fossil Energy coal line programs. It addresses fundamental scientific and engineering problems that are barriers to Fossil Energy technological goals. The AR&TD program is unique in that it is directed to specific scientific and technical areas which are closely connected to long-range Fossil Energy objectives. In contrast, DOE's Office of Energy Research principally supports basic research not specific to fossil energy technologies.

AR&TD research spans the spectrum of coal-related technologies of interest to the Fossil Energy line programs. The goals of this research are to:

- Increase the understanding of the fundamental principles that govern utilization processes;
- Understand the behavior of materials in coal-based systems;
- Conduct crosscutting research that benefits all coal technologies; and
- Provide a focus for supporting novel ideas related to fossil energy technologies.

Specifically, the objectives of AR&TD activities are to:

- Provide a focal point for governmental involvement in fundamental research on coal.
- Expand existing knowledge base, understanding, and verified modeling capability covering those chemical, physical, and thermodynamic phenomena critical to the design and performance of improved coal combustion systems.
- Explore innovative high risk, high potential payoff concepts for coal conversion and utilization.
- Provide a better understanding of the behavior of materials, components and instrumentation in environments associated with those expected to be found in advanced coal combustion and utilization systems.
- Continue the exploration of new materials, catalysts and electrolytes for fuel cell systems.
- Assess and coordinate environmental support for Fossil Energy programs.
- Coordinate the planning and development of a balanced Fossil Energy program.
- Coordinate, assess and plan Fossil Energy advanced research, including international and environmental activities.

To accomplish these objectives, the program is divided into the following functional areas: direct utilization, materials and components, university coal research, and technology crosscut. Technical direction is also provided for the advanced research activities in gasification and liquefaction.

Research is carried out by the Energy Technology Centers, the National Laboratories, universities, and industrial and not-for-profit laboratories.

FY 1986 Accomplishments:

In FY 1986, the AR&TD Program continued to conduct mission oriented fundamental research in the activities listed below:

- o Continued research on the determination of the physical and chemical properties of uncombusted coal-based fuels and solid, liquid and gaseous products produced during the combustion process.
- o Continued research in combustion science, including investigation of fuel injection, atomization, devolatilization and pyrolysis, volatile and char oxidation; the formation and transformation during combustion of pollutants (e.g., ash, alkali, sulfur and nitrogen compounds) and mass and energy transport, including support of the IEA-sponsored coal combustion science initiative.
- o Continued studies on deposition mechanisms before, during, and after combustion, with particular emphasis on ash, mineral matter, and alkalies in conventional and fluidized bed boiler, diesel engine, and gas turbine applications.
- o Continued research on processes relevant to coal beneficiation (e.g., comminution, extraction of sulfur, mineral matter, nitrogen and alkalies) and the control and removal of pollutants during and after combustion.
- o Continued generic electro-chemistry research pertinent to molten carbonate and solid oxide fuel cells.
- o Conducted research on high temperature corrosion, erosion, joining and mechanical properties of heat exchanger materials; reduced the level of effort on corrosion, erosion, and mechanical properties of structural ceramics and refractories.
- o Continued the assessment of unique seal techniques for severe process conditions and development of flow control concepts for hot multiphase gas.
- o Increased support for fundamental research in solids transport.
- o Conducted analyses associated with air and water quality, solid waste disposal, toxic substances, and supported occupational health and safety compliance services.
- o Continued research conducted by the Interagency Task Force on Acid Precipitation (ITFAP).
- o Continued funding of studies which support multi-year planning and Fossil Energy strategy and program formulation, technical/economic assessment studies that crosscut a number of Fossil Energy programs, and support of IEA/Coal Research Service.
- o Continued analyses, studies and technical evaluations in support of FE international activities and provided seed funding for new initiatives and identified advanced research needs.
- o Explored unique methods for measurement of multiphase flow parameters such as velocity, solids content, and viscosity; and for identifying chemical species by advanced methods such as plasma spectrographic techniques.
- o Initiated approximately 30 new university projects relating to coal science, environmental science, surface science, organic and inorganic chemistry of coal constituents and the mechanisms and kinetics of chemical reactions to gasification, liquefaction and combustion.
- o Initiated a cooperative agreement with the University of North Dakota Energy Research Corp. (UNDERC).

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Direct utilization	$11,262	$ 9,415	$ -1,847

This AR&TD subprogram conducts fundamental research to investigate and understand the basic underlying scientific principles that govern the behavior of coal utilization processes. Technology areas that benefit from this knowledge include: boiler, gas turbine and diesel engine applications employing conventional, fluidized bed and advanced combustion techniques; coal preparation and beneficiation, including coal-liquid and pulverized coal characteristics; fuel cells; hot gas cleanup for fuel cells, integrated gasifier and pressurized fluidized bed combined cycle power plants; flue gas cleanup of sulfur, particulate, nitrogen, alkali and trace element pollutants; and waste utilization. Activities are directed toward elucidation of the fundamental physical, chemical, biological and thermodynamic mechanisms inherent in coal utilization science, and include feasibility studies of advanced and novel concepts. A combination of experimental and theoretical research is employed in five major areas:

Properties - Determination of the physical and chemical properties of uncombusted coal, coal-based fuels, and the solid, liquid, and gaseous products produced during the combustion process.

Combustion Science - Study of the combustion process as it pertains to the technologies of interest in atmospheric, pressurized, and internal combustion systems, including investigation of fuel injection, atomization, devolatilization and pyrolysis, volatile and char oxidation; the formation and transformation of pollutants (e.g. ash, sulfur and nitrogen compounds); and mass and energy transport.

Deposition Mechanisms - Study of the mechanisms before, during, and after combustion, with particular emphasis on ash, mineral matter, and alkalies in conventional and fluidized bed boiler, diesel engine, and gas turbine applications.

Separation Processes - Study of the processes relevant to coal beneficiation (e.g. comminution, extraction of sulfur, mineral matter, nitrogen and alkalies) and the control and removal of pollutants during and after combustion.

Electrochemistry - Research on electrolytes, materials, catalysts and advanced fabrication techniques to develop more efficient and durable electrode structures and modeling and analysis capability pertinent to fuel cells.

Major emphasis in FY 1986 was concentrated on the following:

- Research on combustion kinetics and pyrolysis.
- Study of SO_x/NO_x formation in boilers.
- Study of novel means for pollutant (particulates, alkali, sulfur, nitrogen) removal in boilers.
- Research on coal preparation and beneficiation.
- Investigation of coal-liquid slurry rheology and atomization, particularly for non-utility advanced applications.
- Research on fluidized bed particle efflux and tube and wall wastage.
- Investigation of pressurized combustion and deposition mechanisms in advanced combustion concepts.
- Research on novel sorbents for hot gas sulfur compound separation.
- Electrochemistry and catalysis research concerning molten carbonate and solid oxide fuel cells.

The FY 1987 request of $9,415,000 represents a decrease of $1,847,000 from the FY 1986 funding level. At this decreased level, research in the area of properties will be continued at a level comparable with the FY 1986 effort. Research in combustion science, deposition mechanisms, separation processes, and electrochemistry will be continued, but at a reduced level of effort.

In FY 1987, efforts will include:

- Research on advanced pressurized and internal combustion processes applicable to gas turbines and diesel engines, concentrating on atomization and droplet disruption of coal-liquid mixtures, and mechanisms and kinetics of tar, ash and char production, devolatilization, and oxidation within the temperature and pressure profiles of these applications.
- Research on atmospheric combustion processes, concentrating on the mechanisms and kinetics of devolatilization and pyrolysis, the effects of beneficiation, radiative and convective heat transfer, and global char kinetics. This includes studies of low-rank coals and the effects of moisture, particle size, ash composition and alkali concentrations upon them.
- Research on advanced in-situ contaminant control of sulfur, nitrogen, ash and alkali compounds during the combustion process. This includes examination of specialized sorbents and the mechanisms and kinetics of pollutant formation and transformation, mass, momentum and energy transfer.
- Research on slagging and fouling from bituminous coals and increased research on slagging and fouling of low-rank coals, with emphasis on the mechanisms of deposition and the effects of beneficiation, atomization, particle size, and coal composition.

- o Research on novel/advanced processes for post-combustion emission control and innovative methods to control alkalies, nitrogen and sulfur oxides and ash at the atmospheric pressures of boiler flue gas cleanup systems and the elevated pressures of gas turbines.
- o Completion of a study on fluidized bed tube and wall wastage, concentrating on multi-phase particle efflux and erosion mechanisms.
- o Research on electrochemistry and catalysis of advanced fuel cells.
- o Research on coal surface chemistry and the behavior of liquid suspensions as it affects physical, chemical and biological means of separation of mineral matter, sulfur and nitrogen compounds in the preparation of clean coal fuels.

	FY 1986 Approp.	FY 1987 Request	Net Change
Materials and components	$ 9,634	$ 7,453	$ -2,181
Materials	$ 6,899	$ 5,860	$ -1,039

The AR&TD materials studies are directed toward understanding the behavior of materials used in coal-based energy systems. Conditions in coal liquefaction, gasification, combustion, and oil shale processing systems are considerably different from those in conventional energy systems. These advanced technologies encounter unusually high rates of sulfidation corrosion which is aggravated by erosion caused by solid matter. Similarly, high hydrogen partial pressures at higher than normal temperatures, in conjunction with sulfur species, present new aspects of hydrogen attack which are not well understood and must be studied. The significance of these materials problems is confirmed by the premature pilot plant shutdowns caused by material failures.

Typical projected accomplishments in FY 1986 include the following:

- o Comparison of non-destructive evaluation techniques for structural ceramics.
- o Initial assessment of the effect of processing parameters and microstructures on mechanical properties of ceramic-ceramic composites for fossil applications.
- o Continuation of research on joining of iron nickel-aluminides.
- o Continuation of a mechanistic study of the effects of deposits on corrosion of heat exchanger alloys.

Past AR&TD research was primarily directed toward identification of materials which functioned best in specific coal conversion environments. Current research is directed toward understanding the mechanisms of deterioration in situations common to a variety of fossil fuel applications. At the FY 1987 request level, all areas of materials research will be somewhat reduced. Specific activities in FY 1987 include:

- o Assess fracture and corrosion mechanisms in structural ceramics for coal applications.
- o Determine mechanisms of corrosion and corrosion erosion in fossil environments.
- o Collection and dissemination of information to the scientific community.

Components	$ 2,735	$ 1,593	$ -1,142

The goal of components research is to enhance industry's capability to produce reliable, efficient, versatile, and economic plants; it will be achieved through the study and development of advanced components concepts with potential for incorporation into operating systems and through development of fundamental data on process stream properties necessary for component design.

The design of coal-based synthetic fuel facilities and advanced utilization systems (process development units, pilot and commercial plants) is based on experience gained in conventional fossil fueled power plants and petrochemical facilities. The developers and operators of these new facilities experience excessive start-up periods, costly

down-times, and expensive backup systems to achieve acceptable periods of operation because of component reliability.

The primary problem for components in fossil energy systems is the presence of solid materials in process streams. These solids increase wear, erosion, and fouling in pumps, valves, compressors, heat exchangers, filters, and other components.

The typical accomplishments expected in FY 1986 include:

- o Evaluation of the feasibility of a novel slurry pressure let-down device for use as a two-phase flow regulator, and initiation of three-phase tests.
- o Identification of mechanisms of wear in slurry seals.

In FY 1987, the program will continue to have two thrusts: the development of novel components concepts; and solids transport. Four novel components projects will continue in FY 1987: two assessing unique seal techniques for severe process conditions; and two evaluating slurry flow control devices.

The solids transport program was initiated in FY 1984. It consists of two major parts: research on bulk flow, which examines the fundamentals of solids, particularly coal, moving in chutes, hoppers and systems which feed storage bins and reactor vessels; and research on multiphase flow, which examines the fundamentals of flow situations in fossil conversion and utilization systems in which the solids are combined with liquids, or gases, or both. The ultimate objective of these basic studies, which involve modeling with experimental verification, is to improve the basis of components design.

In FY 1985 and 1986, implementation was begun on the recommendations of the planning workshop held during 1984. In FY 1987, the level of effort in this program will be reduced. The program focus will include:

- o Research to understand better the mechanisms of discrete particle flow.
- o Studies of the stability and rheology of suspension systems such as those occurring in coal-liquid mixtures.
- o Modeling and scaleup and design of suspension transport systems such as pneumatic coal slurry transport of solids.

	FY 1986 Approp.	FY 1987 Request	Net Change
Technology crosscut	$ 7,331	$ 6,356	$ -975
Environmental activities	$ 2,345	$ 2,200	$ -145

The FY 1987 request will provide funding for studies supporting Fossil Energy policy development and refinement, R&D assessment and compliance overview in the areas of environment, safety and health (ES&H). The principal analyses supporting policy development will focus on environmental issues related to fossil fuel use and the impacts on fossil energy resources and programs. This environmental effort will provide a policy and management framework for ensuring that ES&H considerations are properly integrated into Fossil Energy programs, and that projects and programs are conducted in compliance with ES&H laws and regulations. The requested funding will ensure that most ES&H compliance activities will be continued, and that the capability to conduct analyses of ES&H issues pertaining to air quality, and solid waste will be maintained. Of specific concern are the ES&H issues associated with emissions, and solid waste residuals. Also included in this request is funding for the research conducted by Task Group B (Manmade Sources) of the Interagency Task Force on Acid Precipitation (ITFAP). The Office of Fossil Energy chairs Task Group B.

Major functions of the environmental activities area include the 1) overview of programs to assure that facilities and projects comply with environment, safety and health

legislation and regulations and 2) studies and analyses of broad issues that have the potential for affecting fossil energy resources and programs. These broad issues could arise from potential legislative and regulatory actions associated with laws such as the Clean Water Act, Resource and Conservation and Recovery Act, Toxic Substances Control Act, and the Clean Air Act. Studies and analyses are conducted with the objective of contributing to the formulation of Fossil Energy positions that are supported by technically accurate data. These studies are an important component of the Fossil Energy policy/planning process, which supports the formulation of Departmental positions and helps to identify new research areas with potentially high payoff. In conducting research in support of Task Group B and ITFAP, emphasis is placed upon studies that support the development of improved data on the nature and level of current and future emissions, particularly for presently uncharacterized species from fossil energy combustion and conversion processes. Accurate inventories of emissions of air pollutants relative to acid deposition, and quality assurance reviews of analytical procedures and uncertainties in emissions data bases by Task Group B are essential to the ability of ITFAP to produce critical assessments. The completion and subsequent revisions to the assessments are an important part of developing a rational, cost effective strategy for dealing with the acid rain problem.

Activities in FY 1986 include:

- o Continue analysis of issues associated with air and water quality, solid waste disposal.
- o Continue efforts on emissions modeling and data for the Interagency Task Force on Acid Precipitation.
- o Continue to support occupational health and safety compliance services.

Similar activities will be continued in 1987 with some change in emphasis.

- o Continuation of support of Interagency Task Force on Acid Precipitation. Limited effort will be focused on quality assurance of analytical tools and data bases.
- o Continuation of support on occupational health and safety compliance services.
- o Continuation of analysis of issues associated with air and water quality and solid waste disposal relative to impacts on fossil energy resources and technologies.

	FY 1986 Approp.	FY 1987 Request	Net Change
Technical and economic analyses	$ 2,151	$ 2,000	$ -151

The FY 1987 request will fund studies supporting multi-year planning and FE strategy and program formulation that are part of the continuing evaluation of Fossil Energy R&D priorities. Technical/economic analyses are needed to support Fossil Energy strategy and program development. These analyses provide a framework to ensure that Fossil Energy priorities are in accord with National goals and strategies, Department of Energy policies, and other important criteria relating to the appropriate federal R&D role. These funds will be utilized to conduct contract studies that crosscut a number of FE programs, such as the future replacement costs of liquid and gaseous fuels from conventional and nonconventional sources, and the analysis of various factors that may impact long-term fossil fuel use and the introduction of new fossil technology in the industrial, utility, residential/commercial and transportation sectors. It is expected that a number of important strategic planning issues requiring further analysis will be identified as a result of FY 1986 energy sector analysis efforts associated with the Interagency Task Force on Acid Precipitation and other major ongoing energy deliberations.

This subprogram also supports the International Energy Agency's London-based Coal Research Service (CRS). The CRS was formerly the Economic Assessment Service and the Technical Information Service which merged in 1984 in order to realize cost savings. It is a multilateral international project, jointly funded by 15 cooperating countries.

The functions of the CRS are the same as its predecessors, namely the consideration of the economics of future coal supply and use and the collection and dissemination of information related to all aspects of coal technology.

It is anticipated that activities supported in FY 1987 will be similar to activities in FY 1986 with modest reductions in scope due to lower funding, and include:

- o Support multi-year planning and Fossil Energy strategy and program formulation studies.
- o Fund technical/economic assessment studies that focus on major end-uses (e.g., transportation and industrial fuels) and thus crosscut a number of Fossil Energy programs.
- o Support IEA/Coal Research Service studies, which will include studies in the areas of coal transportation, utilization and associated environmental issues.

	FY 1986 Approp.	FY 1987 Request	Net Change
Technology base synthesis	$ 779	$ 800	$ +21

This AR&TD subprogram provides overall integration and coordination of research and exploratory development activities that otherwise are often fragmented. It also provides an effective means of applying advances in one technology to the solution of problems in another. The coordination of Fossil Energy international activities is also supported by these funds.

Activities in FY 1986 focused on several important areas:

- o Analyses, studies and technical evaluations in support of the International Energy Agency and bilateral/multinational agreements and activities in which the Fossil Energy Program is involved.
- o Continuation or initiation of several advanced research projects of a multidisciplinary nature that are not easily accommodated by the current program due to their crosscutting nature.
- o Identification of advanced research needs.

The FY 1987 request of $800,000 provides for crosscutting assessments and international coordination of Fossil Energy research. In addition, seed funding is also provided for novel, fundamental research projects.

Specifically, the following activities are expected in FY 1987:

- o Development of an advanced research and technology development project fact sheet system which will provide a basis for program control, program integration and enable management to monitor more closely program execution.
- o Initiate studies designed to assure that research being conducted in the Advanced Research and Technology Development (AR&TD) area is correctly focused and that it addresses the research needs of Fossil Energy technologies. This would include identifying areas where research gaps exist, identifying areas of overlapping research, if any, and serving as a basis for further integration of the AR&TD program.
- o Conduct analyses, studies and technical evaluations in support of multilateral and bilateral international agreement activities in which the Fossil Energy program is involved.
- o Continuation or initiation of several advanced research projects of a multidisciplinary nature that are not easily accommodated by the current program due to their crosscutting nature.

	FY 1986 Approp.	FY 1987 Request	Net Change
Instrumentation, control, and diagnostics	$ 2,056	$ 1,356	$ -700

Measurement of process parameters in fossil energy systems is essential to determination of the nature of a process stream and control of the process. Many critical parameters cannot yet be quantified so accurate design, measurement, and control are not possible. The basic cause is that process streams are multiphase, that is, they may contain solids, liquids, and gases in combinations that are not generally encountered in other systems. Research funded by the AR&TD instrumentation subprogram is directed toward the identification of techniques of measurement rather than development of functioning commercial instruments.

The projected accomplishments in FY 1986 are:

- o Preliminary identification of the limits of high resolution capillary column supercritical fluid chromotography for fossil liquids.
- o Continued research on non-intrusive methods of measuring multiphase process stream parameters.
- o Continued research on a variety of techniques to measure chemical species in process streams.

At the reduced level of funding in FY 1987, the instrumentation, control and diagnostics program will concentrate on the development of techniques to identify chemical species peculiar to fossil systems. The use of laser-induced fluorescence spectroscopy to identify polynuclear aromatic hydrocarbons is an example of such a technique. The development of new instrumentation techniques is critical to the operation and control of advanced fossil systems.

University coal research	$ 5,622	$ 4,000	$ -1,622

The objective of the University Coal Research (UCR) Program is to support meritorious university projects in fundamental goal-oriented research related to all aspects of coal conversion and utilization that are of interest to the Fossil Energy program. However, unlike university projects supported by other Fossil Energy program elements, the University Coal Research projects are different in one or more of the following ways. University Coal Research projects:

- o tend to be longer range and more fundamental research, directed toward improved understanding rather than process improvement.
- o tend to be on crosscutting topics -- e.g., surface reactivity of coal powders, chemistry of mercury in coal hydrogenation and waste treatment, weathering effects on coal structure and reactivity, etc.
- o include student training as one of the project objectives.
- o are chosen from the top 10% of proposals received. Additional meritorious proposals have been offered to and accepted by other Fossil Energy programs.

The following accomplishments are representative of progress expected in FY 1986:

- o Development of improved nuclear magnetic resonance (NMR) techniques for investigating coal structure to determine the types of carbon-carbon and carbon-hydrogen bonds in various coals.
- o Investigation of fundamental processes involved in preparation of superclean coal by flotation of finely ground coals with bubbles/microbubbles of air, nitrogen, or carbon dioxide.
- o Determination of reactions of coal during supercritical extraction with water and organic solvents in the presence of hydrogen and catalysts.

In FY 1987, $4,000,000 is requested, compared with $5,622,000 appropriated in FY 1986. The FY 1987 request will allow for initiation of about 20 university projects compared with about 30 projects in FY 1986. The new grants will be awarded competitively through a Program Solicitation inviting proposals for fundamental research on coal in the areas of primary interest to the Fossil Energy Program. Topics of research will be selected with advice from mainline programs, and will include the following broad areas: coal science, surface science, mechanisms and kinetics, thermodynamics, solids transport and environmental science. Collaboration between university and industrial researchers will be encouraged.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

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FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Coal liquefaction (FE)					
Advanced research:					
Operating expenses	$ 5,511[2/]	$ 5,157	$ 5,157	$ 2,620	$ -2,537
Subtotal	5,511	5,157	5,157	2,620	-2,537
Indirect liquefaction:					
Operating expenses	7,179	9,325	9,325	2,539	-6,786
Subtotal	7,179	9,325	9,325	2,539	-6,786
Direct liquefaction:					
Operating expenses	12,716	12,807	12,807	2,996	-9,811
Subtotal	12,716	12,807	12,807	2,996	-9,811
Support studies/engineering evaluations:					
Operating expenses	5,704	4,331	4,331	992	-3,339
Subtotal	5,704	4,331	4,331	992	-3,339
Total					
Operating expenses	31,110	31,620	31,620	9,147	-22,473
Coal liquefaction	$31,110	$31,620	$31,620	$ 9,147	$-22,473
Staffing Total FTE's: Direct ...	63	72	72	51	-21
Indirect .	22	27	27	22	-5

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

2/ Liquefaction processes ($5.511M) transferred to this activity from the Advanced Research and Technology Development activity.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Coal Liquefaction, (FE)				
Advanced Research				
Operating Expenses	$5,396	$ -28	$-211	$5,157
Indirect Liquefaction				
Operating Expenses	9,757	-51	-381	9,325
Direct Liquefaction				
Operating Expenses	13,399	-69	-523	13,199
Support Studies/Engineering Evaluations				
Operating Expenses	4,531	-23	-177	4,331
Subtotal, Coal Liquefaction ..	33,083	-171	-1,292	31,620
General Reduction:				
Operating Expenses	-171	171	-	-
Total, Coal Liquefaction (FE)	$32,912	-	$-1,292	$31,620
Operating Expenses	32,912	-	1,292	31,620
Capital Equipment				
Construction				

Summary of Changes

FY 1986 Appropriation enacted	$31,620
Program increases and decreases:	
Advanced Research	
o Research will be limited to work conducted at the Pittsburgh Energy Technology Center, the National Institute for Petroleum and Energy Research, and National Laboratories	-2,537
Indirect Liquefaction	
o Conduct research on catalysts and reactor systems at PETC. Eliminate university and reduce cost shared process oriented industrial research	-1,983
o Complete operations of the liquid phase methanol PDU at LaPorte, Texas	-4,803
Subtotal	-6,786
Direct Liquefaction	
o Complete operations of the Direct Coal Liquefaction Research facility at Wilsonville, Alabama	-6,140
o Continue bench scale process research only on existing contracts which will be completed in FY 1987	-2,352
o Restrict laboratory scale investigation of advanced process concepts to PETC in house research	-1,319
Subtotal	-9,811
Support Studies/Engineering Evaluations	
o Complete health effects and biomedical studies	-950
o Complete instrument and component research and research guidance studies	-1,488
o Complete data base management activities	-665
o Reduce laboratory research	-236
Subtotal	-3,339
FY 1987 budget request	$ 9,147

Coal liquefaction:

Program Summary

The FY 1987 budget request for the coal liquefaction technology base totals $9,147,000. The FY 1987 request supports fundamental and applied process research conducted primarily at the energy technology centers, National Labs and cost shared with industrial contractors.

Goals/Objectives:

The Coal Liquefaction program is structured to support the strategic objective established for FE "to increase the effective resource base for premium gas and liquid fuels through enchanced resource recovery and/or production of liquid and gaseous fuel analogs from coal, shale, and tar sands." The specific objective of the Coal Liquefaction program is to continue to add to the information base which supports development by the private sector of economical processes to convert U.S. coals to environmentally and technically acceptable liquid fuels. The program supports long term, potentially high payoff, basic and applied research and development.

Synthetic liquid fuels are an essential part of an energy scenario which provides the U.S. with the means, when required, to reduce reliance on imported petroleum, to have an

answer as absolute supplies of petroleum eventually diminish and to increase the national security of energy supply. Coal is by far the largest fossil energy resource in the U.S. and preparation for its use as a longer term source of liquid fuels is essential as part of the U.S. energy strategy. Coal liquefaction technology, when combined with existing petroleum refining technology, will be able to provide direct replacement products for petroleum derived liquid fuels for heating and transportation. Research and development leading to innovative improvements in the present state-of-the-art will be necessary to improve the market potential of these technologies. With high uncertainty in supplies and prices in upcoming decades in the international petroleum market, the private sector will not undertake the long range, high risk R&D required to develop these improvements.

As the name suggests, direct liquefaction converts the complex organic chemical structures found in coal directly to liquid components by hydrogenation. This requires elevated temperatures and pressures and is almost always carried out in a liquid phase system containing powdered coal and a process derived pasting solvent. In coal/oil co-processing the pasting solvent is a petroleum fraction and therefore is also a feedstock to the process. This reduces or eliminates the need for recycle oil resulting in a much higher throughput for the same size plant, providing substantial reduction in capital cost per unit of output. The major potential advantages of direct liquefaction are high thermal efficiency, and high liquid product yield. The principal disadvantages stem from the severe operating conditions involving coal slurries and the high degree of integration found among process steps. The products have generally aromatic structures (in the chemical sense) because of the structures found in coal and this makes high quality motor gasoline a major product of direct liquefaction. The initial products may contain significant quantities of heteroatoms from the coal (most serious are nitrogen and oxygen) which must be removed by careful process adjustments or by known refining/upgrading treatments. Similarily, heavy aromatic compounds that are known to be biologically active may be present in direct liquefaction products, but these, too, can be reduced or eliminated by process adjustments or further processing.

The production of liquid fuels by indirect liquefaction involves coal gasification to produce a mixture of $CO + H_2$ (synthesis gas) followed by the catalytic conversion of the synthesis gas to liquids. The liquefaction (or synthesis) step is generally less complex from an engineering perspective than direct liquefaction but the overall process is generally less efficient and less selective to fuel grade liquids. The liquefaction step does not have to deal with coal ash and the liquid products which are free of sulfur and nitrogen contamination. The chemical structure of the products can favor production of diesel fuels as a major product. Biological activity and potential health effects are not likely to be a problem with the products of indirect liquid synthesis; the principal waste issues will be related to the synthesis gas production.

Inspection of the advantages and disadvantages of the two routes to liquid fuels from coal indicates that neither approach is clearly superior or preferable for development. The best products from each technology are different enough to suggest that both types of processes may be expected to coexist in any large-scale liquid synfuel industry. For these reasons a significant effort has been ongoing in each area.

In FY 1987, the Coal Liquefaction program continues to support basic and applied research to develop the scientific and engineering knowledge base with which industry can bring economically competitive and environmentally acceptable advanced technology for the manufacture of synthetic liquid fuels from coal into the marketplace when needed.

Specific objectives are to:

- Develop a better understanding of coal liquefaction processes, coal chemistry and related process engineering sciences.
- Expand the knowledge base on the physical, chemical and thermodynamic properties of fossil fuel liquids.

- o Identify advanced, innovative improvements over state of the art processes for coal liquefaction which can utilize the entire U.S. coal base.
- o Develop improvements in product selectivity and quality, and net yield of liquid products per ton of coal.
- o Improve plant operability, on-stream factors, and process operating conditions to reduce capital and operating costs.
- o Utilize synthesis gas produced by modern gasifiers from U.S. coals with a molar hydrogen to carbon monoxide ratio below one.
- o Continue research on coal-oil co-processing using various coals, different oil stocks and operating conditions to provide data on the following improvements:
  - Cost savings possible through the simultaneous upgrading of coal and heavy oil.
  - Infrastructure advantages through introduction of coal into refining processes in an evolutionary fashion.

FY 1986 Accomplishments:

Advanced Research
- o Continued exploration of novel coal liquefaction process concepts, including biological approaches.
- o Continued research to obtain a better understanding of coal liquefaction and reactions of synthesis gas.
- o Continued research on application of new and evolving concepts in catalysis to coal liquefaction.
- o Continued research on the physical, chemical and thermodynamic properties of fossil fuel liquids.

Indirect Liquefaction
- o Completed operation and data acquisition from methanol to gasoline (MTG) pilot plant in collaboration with West Germany using prior funding.
- o Continued to emphasize laboratory research to provide data which will broaden the knowledge of catalyst and reaction systems.
- o Completed research on liquid phase methanol synthesis with operation of and data acquisition from the PDU at La Porte, TX.

Direct Liquefaction
- o Continued laboratory and bench scale research on co-processing heavy oil and coal.
- o Continued bench scale research on the close coupled direct catalytic process.
- o Completed proof-of-concept testing of staged liquefaction at Wilsonville.
- o Continued exploratory studies on new process technology including in-house studies.

Support Studies/Engineering Evaluations
- o Completed biomedical studies with emphasis on products from co-processing coal and residual petroleum and from advanced staged liquefaction processes.
- o Completed research guidance studies and instrument and component research.
- o Completed liquefaction data base management activities. Focused on analysis and consolidation of data, including some modeling.
- o Continued laboratory research in support of process studies. Emphasis on solvent characterization, reaction kinetics and catalyst characterization and deactivation mechanisms.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Advanced research	$ 5,157	$ 2,620	$ -2,537

The main focus of this program is small scale, fundamental phenomenological studies in coal liquefaction. Research areas include catalysis and kinetics and mechanisms of indirect liquefaction. Other studies leading to advanced liquefaction concepts include hydroextraction of coal, the effects of specific solvent components on kinetics and liquefaction products, and biological approaches to coal liquefaction.

In addition, this program consolidates and augments scientific research on the physical, chemical, and thermodynamic (PCT) properties of fossil fuel liquids. It is responsive to the often identified need to improve the fundamental understanding and existing information base on liquid properties related to synthetic fuels processing. The ultimate goal is to develop simple predictive techniques for identifying PCT properties of fossil fuel liquids relevant to synthetic fuel technologies.

The Advanced Research (AR) liquefaction activity is significantly different from the other line liquefaction subprograms in the following ways:

More fundamental - The AR program supports research on correlation of coal properties with reactivity for liquefaction. Examples include nuclear magnetic resonance (NMR) probing of coal and coal-solvent interactions; investigation of the structure of low rank coal; acquisition of physical, chemical, and thermodynamic (PCT) data on coal liquids; and the Penn State Coal Sample Bank. The other subprograms have little or no such activities. Information from this research aids the other line subprograms by providing fundamental information and data to assist in improvement of coal liquefaction processes.

Higher risk and more exploratory - The AR program supports high risk approaches to coal liquefaction such as electrochemical and biological methods, and the use of supercritical extraction and unconventional solvents. Characteristically, the economics of these approaches are not known. AR approaches that show promise may be expected to "graduate" to the other line subprograms.

Smaller scale - AR projects are invariably conducted on a small scale, not involving continuous units and not above a laboratory scale.

Typical projected accomplishments in FY 1986 include the following:

- o Completion of initial evaluation of several microorganisms for biological liquefaction of coal.
- o Investigation of the synthesis and evaluation of novel, highly active catalytic materials based on hydrous oxide support materials that offer unusual versatility for catalyst formulation.
- o Elucidation of chemical pathways for hydrogen consumption and redistribution under different coal liquefaction conditions.
- o Quantification of structural features of low rank coal.
- o Selection and maintenance of a group of 50 coal samples representative of U.S. coal resources to provide high quality coal samples and related compositional data to coal researchers.
- o Measurement of accurate PCT data on organic sulfur and nitrogen compounds that are models for substances found in coal derived liquids.

In FY 1987, $2,620,000 is requested, a decrease of $2,537,000 from the FY 1986 funding level. Research will be continued at the Pittsburgh Energy Technology Center, the National Institute for Petroleum and Energy Research, and National Laboratories. The research efforts will continue on the properties of coal liquids and reaction mechanisms during the coal liquefaction process. Limited industrial and university research on novel catalytic, biological and other coal liquefaction processes will continue. Research will also continue on the physical, chemical and thermodynamic properties of fossil fuel liquids.

	FY 1986 Approp.	FY 1987 Request	Net Change
Indirect liquefaction	$ 9,325	$ 2,539	$ -6,786

The FY 1987 funding request for Indirect Liquefaction is $2,539,000, a decrease of $6,786,000 from the FY 1986 funding level. This decrease can be attributed to new

program policy guidelines directing Fossil Energy R&D efforts away from proof-of-concept and industrial research and towards in-house research studies. Specific changes to this program are the elimination of the LaPorte liquid phase methanol PDU project and reorientation of catalyst and reactor studies to in-house work at PETC while continuing certain cost shared industrial research projects.

Indirect liquefaction is a technology which can produce by catalytic synthesis a variety of liquid fuels, including gasoline, distillate fuels and furnace oils, and alcohols, from gaseous feedstocks. These products are suitable for virtually all U.S. market sectors including the transportation, residential, industrial/commercial and utility markets. The DOE program has as its primary objectives the following:

- o achieving more selective and economic liquid fuel yields, and
- o achieving better utilization of coal-derived (low hydrogen content) gas feedstocks.

To accomplish these objectives, major emphasis is placed on improved reactor systems and advanced catalysts because these contribute most to the yields, economics, and feed flexibility of indirect liquefaction processes.

A commercial (Fischer-Tropsch) process was first conceived during the 1930's to convert low carbon monoxide content gas to a broad range of liquids. While evolutionary improvements have been made, the commercial process still has inherent limitations. A major limitation is the production of large quantities of by-product chemicals for which there is no significant market in the U.S.

The broad based research program now in place is effectively investigating the technology for converting the high carbon monoxide content (low ratio H_2/CO) synthesis gas produced by the modern gasifiers, including those marketed by U.S. industry, to quality fuels. Current research is emphasizing homogeneous catalysts and heterogeneous catalysts with shape selectivity and bi-functional capabilities. The new technology eventually will selectively produce the desired, high quality fuels without the extensive downstream processing required in the past. Reactor designs which are necessary to provide close control of the reaction temperature and recover the exothermic heat of reaction are a part of the program.

The indirect liquefaction program in FY 1986 emphasized the study of advanced catalysts and chemical reactions. The methanol to gasoline (MTG) pilot plant also completed operations in West Germany using FY 1984 funds. This facility is supported equally by DOE, the West German government, and industry. The MTG plant demonstrated the versatility of the basic process concept by producing olefins from methanol. The olefins can be converted to high quality diesel fuel in an existing process, thus providing an efficient route for the production of diesel fuel, as well as gasoline, from methanol. PETC continued basic studies of the direct synthesis of liquid fuels including catalyst composition, preparation, activation techniques and slurry phase reactions. A number of laboratory scale research projects were also underway with industrial and university organizations to investigate catalysts and reaction mechanisms in order to improve product selectivity and yields. Reactor designs including gas fluidized three phase systems were under development.

Research to investigate the concept of producing methanol in a slurry phase reaction from carbon monoxide rich synthesis gas continued. This liquid phase methanol concept could provide electric utilities a valuable option at advanced, combined cycle power plants. Some of the coal derived synthesis gas will be converted to liquid methanol to be available as a fuel for peak electricity generation. Unconverted gas will be a turbine fuel for base load use.

In FY 1987, the indirect liquefaction subprogram will continue laboratory research to provide data for better understanding catalyst and reaction systems which permit the direct utilization of coal derived synthesis gas to produce high quality gasoline, distillate or alcohol fuels selectively. This research will be conducted at PETC and at some industrial facilities under existing contracts.

	FY 1986 Approp.	FY 1987 Request	Net Change
Direct liquefaction	$12,807	$ 2,996	$ -9,811

This subactivity has supported the development of innovative improvements that have the potential for yielding significant cost reductions in direct liquefaction technologies. Based on previous research, feasible improvements have been identified and the Direct Liquefaction subprogram has conducted research to exploit these improvements by evaluating process concepts that offer potential for lower hydrogen consumption, higher liquid yields, higher quality products, and greater flexibility in feed coal and product slate selection. Elements of the program have included catalyst development and evaluation, laboratory and integrated bench scale process research, and proof-of-concept evaluations at a 6 ton per day scale at Wilsonville, Alabama. In FY 1987 the program will be reoriented to an in-house technology base program conducted at Pittsburgh Energy Technology Center. Several existing industrial research contracts ending in FY 1987 will be completed.

Process development activities for near term direct liquefaction technologies are considered technically ready for larger scale demonstration by the private sector. Proof-of-concept testing of the staged liquefaction process was completed at Wilsonville in FY 1986. A substantial data base on this newer process concept is now available over a range of conditions with both bituminous and subbituminous coals. No funds are requested for Wilsonville in FY 1987.

Based on a competitive multiyear award two cost-shared industrial projects have been evaluating the co-processing of coal with heavy oil since October 1984. The objective is to evaluate the technical feasibility and establish a process data base on this concept. Co-processing is a new concept in coal liquefaction that offers the potential for substantial cost reduction and for acceleration of the introduction of coal-derived fuels into the marketplace by utilizing to a greater extent existing petroleum refinery technology and equipment. The work completed to date has established the technical feasibility of the process. Screening work completed in FY 1985 showed that high coal conversions and good liquid yields can be obtained using U.S. bituminous and subbituminous coals with a number of U.S., Canadian, and other imported crude oils. Preliminary continuous bench scale studies in FY 1986 will establish operating performance over a range of operating conditions. In FY 1987 each project will be completed with additional bench scale studies and preparation of a preliminary conceptual design.

Bench scale testing of a close coupled catalytic direct liquefaction process was continued in FY 1986 to develop improvements in process performance and economics. In FY 1987 this project will be completed with further bench scale research and preparation of a preliminary conceptual design.

A number of laboratory activities in the technology base and screening test area being carried out under contracts with industry and universities will be completed in FY 1986 and no additional funds are requested for this activity.

Funds are being requested to continue in-house, technology base research at PETC. The PETC projects are focused on new direct liquefaction process concepts and analytical studies to improve understanding of coal liquefaction reaction mechanisms and catalysts. In FY 1987, at least three areas will be pursued: (1) studies of coal conversion catalysts; (2) co-processing of coal with heavy oil; and (3) use of non-conventional chemical systems in Direct Liquefaction. If available, evaluations of technology data from the Japanese will also be conducted.

In FY 1986 an international agreement for R&D research between DOE and Italy was initiated which includes a laboratory scale project in liquefaction. This project will continue in FY 1987.

	FY 1986 Approp.	FY 1987 Request	Net Change
Support studies/engineering evaluations	$ 4,331	$ 992	$ -3,339

This subactivity supports the overall coal liquefaction program and includes studies applicable to all of the technologies under development. The studies have included independent technical status reviews for research guidance, instrument and component research, environmental and technological R&D, and generic laboratory research supportive of process research. Data management has also been included with emphasis on capture of the information from the previous large scale projects and modeling studies to make data available and useful to industry. In FY 1987 this subactivity will be reoriented to a technology base program in liquefaction research conducted at Sandia National Laboratory. An industrial contract in technology base research will also be continued.

Certain fractions of coal-derived liquids have produced toxic effects in laboratory animals. A technology oriented health effects (biomedical) test program is underway which is coordinated with the health effects program of the Office of Energy Research. Undesirable components are characterized and efforts made to evaluate techniques to reduce toxic materials in a manner compatible with liquefaction processes. Previous work has provided assessment of material from two-stage liquefaction processes and initial tests on co-processing products. Long term skin painting studies continued to evaluate various levels of hydrotreatment to destroy bioactive substances. Data developed in the program can be used by industry to identify process configurations or operating conditions needed to minimize production of toxic substances. This activity will be completed in FY 1986.

Research and development has been needed to help improve critical mechanical components and controls identified as problem areas for pilot and commercial scale operations. Past projects provided significant advances in slurry pump operation and slurry metering instrumentation. In FY 1986, work was continued in deashing feed monitoring instrumentation and solvent quality enhancement and measurements. Funds are requested for this work in FY 1987 to complete one industrial research project on instrumentation.

In FY 1986, efforts were continued on generic laboratory research in support of the process research activities, such as experimental studies on catalyst deactivation mechanisms, process solvent characterization, and reaction kinetics and mechanisms. In FY 1987, work will continue on developing improved understanding of kinetic effects of importance to advanced liquefaction processes along with work on solvent and catalyst characterization techniques.

In prior years, work has been supported in liquefaction information management activities. The objective of this project has been to develop and implement an information management system to collect, evaluate and disseminate liquefaction research and development data from past large scale operations. In FY 1985, data acquisition activities were completed for the major liquefaction project activities (SRC-II, H-Coal, EDS). In FY 1986, efforts were focused on further analysis and consolidation of this data as well as adding data from advanced process research activities to the information base. This project will be completed in FY 1986.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 1/ Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Combustion systems (FE)					
Atmospheric fluidized bed combustion:					
Operating expenses	$18,737	$16,572	$16,572	$ 1,590	$-14,982
Subtotal	18,737	16,572	16,572	1,590	-14,982
Pressurized fluidized bed combustion:					
Operating expenses	2,458	5,061	5,061	3,686	-1,375
Subtotal	2,458	5,061	5,061	3,686	-1,375
Advanced combustion technology:					
Operating expenses	1,967	3,409	3,409	1,882	-1,527
Subtotal	1,967	3,409	3,409	1,882	-1,527
Alternative fuels:					
Operating expenses	6,930	4,071	4,071	2,011	-2,060
Subtotal	6,930	4,071	4,071	2,011	-2,060
Total					
Operating expenses	30,092	29,113	29,113	9,169	-19,944
Combustion systems	$30,092	$29,113	$29,113	$ 9,169	$-19,944
Staffing Total FTE's: Direct	34	24	24	20	-4
Indirect	24	24	24	19	-5

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Combustion Systems (FE)				
Atmospheric Fluidized Bed Combustion				
Operating Expenses	$17,341	$ -92	$-677	$16,572
Pressurized Fluidized Bed Combustion				
Operating Expenses	5,296	-28	-207	5,061
Advanced Combustion Technology				
Operating Expenses	3,569	-21	-139	3,382
Alternative Fuels				
Operating Expenses	4,257	-20	-166	4,071
Subtotal, Combustion Systems..	$30,463	$-161	$-1,189	$29,113
General Reduction:				
Operating Expenses	-161	161	-	-
Construction				
Total, General Reductions				
Total, Combustion Systems (FE)	$30,302	-	$-1,189	$29,113
Operating Expenses	30,302	-	-1,189	29,113

Summary of Changes

FY 1986 Appropriation enacted	$ 29,113
Program increases and decreases:	
Atmospheric Fluidized Bed Combustion	
o Complete funding of TVA demonstration project in FY 1986	-14,334
o Complete advanced concept bench scale testing	-762
o Continue special application PRDA to be issued in FY 1986	+299
o Discontinue coal characterization (LRC) studies and economic design follow-on. Continue in-house research on particle motion flow, erosion, bed internals and heat transfer surfaces	-185
Subtotal	-14,982
Pressurized Fluidized Bed Combustion	
o Complete cost-shared program with industrial sector for high efficiency advanced PFB concepts following completion of Phase I systems definition studies	-695
o Complete testing of advanced hot gas cleanup devices at New York University and continue test program to obtain data on combustion characterization heat transfer and provide a basis for advanced concept designs	-169
o Complete metals wastage studies on the mechanisms and kinetics of coal/sorbent combustion products, materials survivability, etc., in a PFB environment and terminate experimental testing program to verify laboratory testing	-480
o Reduce in-house research effort on PFB dynamics, data analysis, and engineering/systems analysis	-31
Subtotal	$ -1,375
Advanced Combustion Technology	
o Complete efforts associated with the AVCO advanced slagging retrofit combustor project	-765
o Complete Phase I efforts. Phase II efforts will be initiated at a reduced effort	-255
o Continue in-house activities supportive of generic advanced combustion technology	-74
o Complete funding of the AVCO pulsed combustor project	-433
Subtotal	-1,527
Alternative Fuels	
o Reduced the scope of light industrial/commercial applications PRDA for detailed combustion and fuel handling characterization R&D for CLM/micro-pulverized coal fuels in selected light industrial and commercial furnaces/boilers	-2,060
FY 1987 budget request	$ 9,169

Combustion systems:

Goals/Objectives:

The goal of the Combustion Systems activity is to increase the contribution and application of the nation's coal resources through the development of acceptable combustion systems and fossil-derived fuels for the marketplace. The programs within the overall Combustion Systems activity are Atmospheric Fluidized Bed, Pressurized Fluidized Bed, Alternative Fuels and Advanced Combustion Technology.

The objective of the AFB program is to broaden the market and utilization of coal by expanding the technology application to the light industrial, commercial/institutional and residential sectors in an economical and environmentally acceptable manner. While there are 19 U.S. manufacturers of AFB's, the units are competitive with oil and gas only in the 150,000 pound of steam per hour sizes and larger. The smaller units installed in the light industrial sector are economically competitive only on a case-by-case basis, i.e., cogeneration, high capacity, supplemental waste fuel, etc. This program will develop generic AFB's for the entire market that compete economically and environmentally with oil and gas.

The Pressurized Fluidized Bed Combustion program objective is to establish the technology which will enable industry to demonstrate and commercialize first entry systems by the early 1990's and to extend the technology by developing data for advanced PFB concepts which provide quantum improvements in system efficiency and substantial reductions in the cost of electricity.

The objective of the Advanced Combustion Technology program is the development of technology that will permit the use of coal in boiler, furnace and heater applications now using oil or natural gas. This would include the retrofit of existing equipment as well as the design of new systems to optimize the use of the new technology developed.

The Alternative Fuels program objective is to establish the technology for light industrial/commercial/residential combustion systems that defines the ability of those systems to technically, economically, environmentally, and socio-aesthetically accommodate coal liquid mixtures and other coal-based fuels as a means of displacing the oil and/or natural gas presently consumed by those systems.

FY 1986 Accomplishments:

Atmospheric Fluidized Bed Combustion

- o Completed operations of the East Stroudsburg and Wilkes-Barre AFB units.
- o Completed economic system studies of advanced concepts and initiated bench scale construction and testing.
- o Completed funding support of the 160 MW TVA demonstration plant.
- o Continued economic studies of critical cost elements, conducted coal characterization studies/burn tests (LRC) and in-house erosion research.
- o Award contracts for special applications PRDA.

Pressurized Fluidized Bed Combustion

- o Continued testing at NYU to obtain data on performance of advanced hot gas cleanup devices.
- o Completed the laboratory experiment program to evaluate erosion/corrosion of PFB materials (in-bed tubes, gas turbine blades).
- o Continued in-house research on data and engineering/system analysis.
- o Initiated a cost shared follow-on effort to test key critical PFB process components, i.e., tube bundle, CWM slurry feeding, hot gas cleanup.
- o Initiated Phase I of cost shared program with industry for advanced PFB systems with improved economic and high efficiency.

Advanced Combustion Technology

- o Completed the Advanced Slagging Combustor project (TRW).
- o Initiated PRDA for coal fired systems for light industrial, commercial/institutional and residential applications.
- o Completed AVCO slagging combustor project including tests on the bench scale unit.
- o Initiated in-house testing on coal fired units with varying air fuel ratios and coal based fuels for emissions characterization and market sector application.
- o Completed AVCO pulsed combustor project.

Alternative Fuels

- o Defined the "suitability" and "extent" of continued characterization R&D for specific combustion system configurations for light industrial/commercial and residential boiler/furnace applications of CLM/micro-coal fuels.
- o Continued emissions characterization to address effluents/intrusions from CLM use.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Atmospheric fluidized bed combustion	$16,572	$ 1,590	$-14,982

The objective of the AFB program is to broaden the market and utilization of coal by expanding the technology application to the light industrial, commercial/institutional and residential sectors in an economical and environmentally acceptable manner. While there are 19 U.S. manufacturers of AFB's, the units are competitive with oil and gas only in the 150,000 pound of steam per hour sizes and larger. The smaller units installed in the light industrial sector are economically competitive only on a case-by-case basis, i.e., cogeneration, high capacity, supplemental waste fuel, etc. This program will develop generic AFB's for the entire market that compete economically and environmentally with oil and gas.

FY 1986 funds were utilized to complete economic systems studies and commence bench scale testing of Advanced Concepts; initiate bench scale designs of Special Applications; continue coal characterization studies/burn tests (LRC); continue economic studies of critical cost elements; continue fluidization research and complete funding support of the TVA 160 MWe demonstration project.

FY 1987 funds will be utilized to complete designs and initiate construction and testing of the most promising of the special application bench scale units and conduct basic in-house research on particle motion flow, erosion, bed internals and heat transfer surfaces.

Pressurized fluidized bed combustion	$ 5,061	$ 3,686	$ -1,375

The pressurized fluidized bed (PFB) combustion program objective is to develop PFB combustion systems that achieve high combustion efficiency and acceptable component durability and reliability while staying within acceptable emission levels. The goal of DOE sponsored activities is to develop PFB scientific and engineering technology data through proof-of-concept to support private sector efforts to demonstrate and commercialize first entry PFB systems for electric power generation in the 1990 time frame.

In FY 1986, the follow-on effort was initiated at the Grimethorpe facility to develop data on combustion efficiency, hot gas cleanup performance, coal water slurry feeding and performance of an updated heat exchanger design. This effort is cost shared with the British National Coal Board, EPRI and United States industry. Additionally, the New York University facility completed operations to obtain data on advanced hot gas cleanup devices. The PFB Advanced Concepts (second generation) program was initiated as a cost-shared effort with industry to develop systems which would offer significant improvements in process economics, reliability, operability and environmental performance.

The FY 1987 funds will be utilized to continue the Grimethorpe follow-on test program on hot gas clean-up, coal water slurry feeding and performance of updated heat exchangers. Efforts at NYU will be continued to evaluate components and design changes to enhance performance and provide the basis for advanced concepts. The METC effort would continue research and development support of the first generation systems development including component evaluation and combustion performance characterization as well as testing of in-house PFB reactors (both hot and cold) to develop paramters that affect particle movement and impingement on heat exchanger surfaces. These efforts are being directed

towards providing the technical data needed by industry to demonstrate first generation combined cycle and turbocharged systems. Additionally, efforts would be completed for the first phase of the Advanced Concepts program which would define the system, identify technology development needs and provide a conceptual design of an advanced PFB electric power plant. Finally, funding will be used for the Advanced Concept program by initiating the second phase efforts for development and testing those key critical process components which would impede commercialization. The Advanced Concepts (Second Generation) program would develop systems which provide a quantum leap in cycle performance (increase efficiency 40% to at least 45%) and substantial reductions in the cost of electricity (reduce cost by at least 20% over conventional coal-fired systems with flue gas desulfurization). The Advanced Concepts program goal is to provide the technology at sufficient scale to enable industry to proceed with pilot scale testing by the mid to late 1990's.

	FY 1986 Approp.	FY 1987 Request	Net Change
Advanced combustion technology	$ 3,409	$ 1,882	$ -1,527

The objective of the Advanced Combustion Technology program is to develop the equipment which will enable existing oil and gas fired boilers, furnaces and process heaters to be retrofitted to burn coal or coal-water mixtures (CWM). This activity is also concerned with the development of new or innovative concepts that will extend the use of coal to smaller commercial and residential markets. The technology development will be applicable to the design of new systems that have the advantage of versatility, environmental cleanliness, and acceptable economics as compared to boilers that utilize conventional direct coal combustion.

In FY 1986, efforts were concentrated on the completion of Phase I of the AVCO Slagging Combustor Project, testing and evaluation of the TRW Slagging Combustor, and a novel pulsed combustor (AVCO) study contract. Conceptual designs and bench scale testing of these innovative combustion concepts were completed. In addition, the light industrial concepts RFP planned for FY 1985 was redirected and combined with an FY 1986 PRDA for commercial and residential concepts. This PRDA resulted in the award of contracts and initiation of Phase I activities (economic and environmental assessments) in FY 1986. At PETC, an in-house effort was initiated in FY 1986 to investigate SO_x and NO_x emissions at varying air/fuel ratios. Studies related to dense phase transport of solids and fuel characterization were performed. Data collected from these activities were organized and archived at PETC.

The FY 1987 request will be used to continue the development of Light Industrial, Commercial, and Residential concepts selected from the FY 1986 PRDA. This will include the design, fabrication, and installation of hardware and some operational testing. Generic in-house activities supportive of these projects will continue at PETC, including fuel characterization efforts and the operation of small size combustors to study NO_x and SO_x emission at varying air/fuel ratios. Dense phase transport studies and the collection and management of data will continue.

Alternative fuels	$ 4,071	$ 2,011	$ -2,060

FY 1987 represents a change in program direction towards a more limited Federal role in support of long-term, high-risk R&D. Therefore, the FY 1986 budget is addressed as a transitional period from the current product development/proof-of-concept philosophy with varying levels of possible Federal support to basic technology research areas with specified maximum percent levels of Federal support.

As a result of this redirection, FY 1986 funds will be used to address the use of CLM fuels in residential applications, and the planned PRDA to examine the use of these fuels in the light industrial/commercial sectors will be reduced in scope to be completed in FY 1987 with FY 1986 funds.

The objective of the alternative fuels activity is to provide the technology development necessary to establish a technology base for retrofitting coal-liquid mixtures to existing oil and gas designed facilities with emphasis on coal in slurry form. The R&D effort will generate a data base sufficient for private sector assessment as to the commercial acceptability of these coal-based fuels for their site specific needs in both retrofit and new capacity applications.

In FY 1986, funds were used for generic combustion characterizations to identify specific light industrial, commercial and residential combustor configurations having a high technical potential for CLM and/or micro-pulverized coal fuel use; and to define a detailed combustion characterization R&D activity for those units adequate to yield the quality and quantity of data required for private sector use and decision.

FY 1987 funds will be used to complete detailed combustion and component characterization R&D for CLM/micro-pulverized coal fuels in selected existing light industrial, commercial and residential boiler/furnace systems. Also, detailed technical, economic, environmental and socio-aesthetic assessments on the use of CLM fuels in these systems will be completed. The specific characterization R&D and assessment efforts will render detailed documentation for private sector use that identifies/determines the adequacy of the selected equipment to accommodate CLM/micro-pulverized coal fuels.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 1/ Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Fuel cells (FE)					
Phosphoric acid systems:					
Operating expenses	$28,573	$20,355	$20,355	$ ...	$-20,355
Subtotal	28,573	20,355	20,355	...	-20,355
Molten carbonate systems:					
Operating expenses	8,851	9,932	9,932	3,400	-6,532
Subtotal	8,851	9,932	9,932	3,400	-6,532
Advanced concepts:					
Operating expenses	3,048	3,770	3,770	1,600	-2,170
Subtotal	3,048	3,770	3,770	1,600	-2,170
Total					
Operating expenses	40,472	34,057	34,057	5,000	-29,057
Fuel cells	$40,472	$34,057	$34,057	$ 5,000	$-29,057
Staffing Total FTE's: Direct	0	0	0	0	0
Indirect	13	11	11	5	-6

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Fuel Cells (FE)				
Phosphoric Acid Systems				
Operating Expenses	$21,300	$-113	$-832	$20,335
Molten Carbonate Systems				
Operating Expenses	10,400	-62	-406	9,932
Advanced Concepts				
Operating Expenses	3,942	-18	-154	3,770
Subtotal, Fuel Cells	$35,462	$-193	$-1,392	$34,057
General Reduction:				
Operating Expenses	-193	193	-	-
Total, Fuel Cells (FE)	$35,449	-	$-1,392	$34,057
Operating Expenses	35,449	-	1,392	34,057

Summary of Changes

FY 1986 Appropriation enacted	$34,057
Program increases and decreases:	
Phosphoric Acid Systems	
o Complete all funding for development of the 11MW and 7.5 MW electric utility systems, on-site water-cooled and dielectric cooled systems and leave full responsibility to the private sector for any further development and application of these technologies	-20,355
Molten Carbonate Systems	
o Continue the development of external reforming and internal reforming fuel cell stacks. Continue efforts to develop improved components and corrosion resistant materials for molten carbonate cells	-6,532
Advanced Concepts	
o Continue research and development of solid oxide technology and critical materials	-2,170
FY 1987 budget request	$ 5,000

Fuel cells:

Goals/Objectives:

The objective of the Fuel Cells program is to support high risk, high payoff technology base development and to assist private industry in developing hydrocarbon fuel conversion technologies to increase the cost effective, efficient and environmentally acceptable use of conventional and alternative hydrocarbon fuels. The Administration position is that this objective will have been achieved for phosphoric acid systems by the end of FY 1986 and full responsibility will be left to the private sector for further development and application of phosphoric acid fuel cell technologies. The International Fuel Cell Corp. (IFC), a partnership of United Technologies and Toshiba of Japan, has already announced plans to market 11 MW systems based on the DOE-funded design.

Fuel cells are electrochemical (not combustion/Carnot cycle-limited) conversion systems which are highly efficient (40 to 60 percent), fuel-flexible, modular, and environmentally attractive energy conversion systems.

Potential fuel cell applications include electric utility multi-megawatt power plants (with or without cogeneration) and on-site multi-kilowatt cogenerating systems, transportation applications to include railroad, marine, trucks and buses (which represent 35 percent of oil consumption in transportation), defense applications including remote radar stations and stationary facilities, marine and submarine systems, and mobile power supplies with low infrared and noise signatures.

Fuel cell power plants can be sited at the point of both electrical and thermal energy need of stationary applications. With the power plant installed on-site, the heat produced by the plant while generating electricity can help meet the thermal needs of the consumer with reduced distribution and transmission losses. Fuel cells offer an energy conversion choice of interest to a broad sector of the economy. They have the potential of generating electricity with a wide spectrum of fuels including synthetic liquids (methanol, etc.), natural gas, and gases from coal, biomass and waste.

First generation phosphoric acid fuel cells potentially can be used in the following applications: electric utility dispersed peaking, intermediate and spinning reserve, building total energy systems, waste fuel recovery (e.g., industrial waste hydrogen,

anaerobic digestors, and solid waste), industrial cogeneration, and defense applications. Because of their inherent advantages and potential, private industry has a strong incentive to support the development and commercialization of phosphoric acid fuel cells.

Advanced second generation molten carbonate and solid oxide fuel cells potentially can be used in: electric utility intermediate, baseload, on-site integrated energy systems and industrial cogeneration applications. These advanced fuel cell power plants can be integrated with coal gasifiers and can be bottomed with a steam or a gas turbine delivering electricity at approximately 50 percent efficiency (coal pile to busbar). Advanced fuel cell technical development trails behind phosphoric acid development but provides a potential of increased efficiency and reduced cost. It is therefore still an appropriate target for Federal support.

The technical feasibility of phosphoric acid fuel cells utilizing clean fuels (i.e., natural gas) has been established by testing preprototype systems in excess of 200,000 operating hours (cumulative hours on about 40 power plants to date). Emphasis has been on technology improvement to reduce the cost and increase the power density and endurance of phosphoric acid power plants, and to verify the operational feasibility in on-site and electric utility applications. The technical feasibility of molten carbonate fuel cells operating at approximately 60 percent electrical conversion efficiency (natural gas to busbar) has been forecasted by single cell testing. The complexity and associated capital costs of advanced fuel cell systems are projected to be less than those for first generation systems.

Solid oxide electrolyte fuel cells have the advantage of solid state stability and have been projected to be more easily manufactured. The operating temperature of 1800°F allows a highly efficient bottoming cycle with projected power plant efficiencies of approximately 50 percent.

FY 1986 Accomplishments:

Phosphoric Acid Systems
- o Continued technology development of water-cooled on-site systems; performed verification tests of prototype stack and plant subsystems.
- o Initiated testing of 25 kW on-site system including dielectric-cooled stack, fuel processor and inverter.
- o Continued inverter and stack technology work on the 11 MW water-cooled electric utility system through development of stack configuration "B".
- o Continued electric utility R&D with air-cooled stacks for a 7.5 MW system; began tests of 25 kW stacks and tests of 100 kW engineering model stack.
- o Continued a small activity for analytical evaluations in support of the above development efforts.

Molten Carbonate Systems
- o Completed verification testing of first external reforming, large area short stack.
- o Completed Energy Research Corporation's direct fuel cell technology in small cells.
- o Initiated PRDA for further development of external and/or internal reforming stacks.
- o Initiated development of a contaminant resistant fuel cell capable of processing gases containing sulfur and chlorine.
- o Continued system studies and research on cell corrosion and electrode stability.
- o Continued studies at ANL on new cathode materials and supporting research.

Advanced Concepts
- o Continued R&D effort at Westinghouse with fabrication and initial tests of 5 kW preprototype module.
- o Continued system studies and research on cell materials, cell fabrication techniques and evaluation of new concepts.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Phosphoric acid systems	$20,355	$ ...	$-20,355

The Department is requesting no FY 1987 funding for phosphoric acid fuel cell development and proposes that further development be solely the responsibility of the private sector.

The objective of the phosphoric acid fuel cell program through FY 1986 has been to develop the technology for electric utility and on-site systems so that the private sector can demonstrate and commercialize powerplant systems in the post-FY 1986 time period. The program has been cost shared with the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), manufacturers and participating utilities.

In prior years, research and development efforts on phosphoric acid fuel cells have resulted in the demonstration of forty six 40 kW on-site fuel cell powerplants in gas utility service. Research and development funding has also provided for continuing the development of follow-on (higher power level) advanced, on-site powerplants which the private sector expects to commercialize in the 1987-1988 time period. Phosphoric acid fuel cell research and development efforts have also provided the technology verification of pressurized, large area (120 psia, 10 ft^2) fuel cell stacks for a commercial prototype 11 MW system, and early development of the cell and stack for an alternate 7.5 MW system.

FY 1986 funds were utilized to continue development of a water-cooled on-site system with verification testing of a prototype stack and plant subsystems as well as to continue development of a dielectric-cooled on-site system with testing of a 25 kW unit including stack, fuel processor and inverter. FY 1986 funds were also utilized to continue development of inverter and stack technology applicable to an 11 MW water-cooled electric utility system through development of stack configuration "B", as well as to continue development of a 7.5 MW system with tests of 25 kW and 100 kW stacks. Supporting analytical evaluations effort was continued at a low level.

The phosphoric acid fuel cell technology has, as a result of these developments and demonstrations, reached a maturity level such that the private sector can now assume full responsibility for the continuation of development and commercialization of this technology. No activities are proposed in FY 1987.

Molten carbonate systems	$ 9,932	$ 3,400	$ -6,532

The FY 1987 budget request will continue FY 1986 research activities at a reduced level of effort in the areas of external and internal reforming molten carbonate fuel cell stacks, cell components, and corrosion resistant materials. The private sector would be expected to assume a larger role in further development of molten carbonate fuel cell systems.

The objective of the molten carbonate fuel cell program has been to develop an advanced, high performance fuel cell technology for electric utility and industrial cogeneration applications. The technology would have the capability of using conventional hydrocarbon fuels such as natural gas or coal-derived gas. The program has been cost shared with EPRI.

In prior years, research and development efforts have resulted in the demonstration of short (20 cell) stacks and the initial verification of internal fuel reforming in single cells. A research effort has also been conducted to model the effects of sulfur contaminants on cell performance.

FY 1986 funds were utilized to continue technology activities associated with cell contaminants, corrosion mechanisms and mechanical deformation of stacks. FY 1986 funds

were also utilized for the completion of development and test verification of an external fuel reforming, full area short stack and internal fuel reforming technology in small stacks. A PRDA was issued in FY 1986 for the further technology development of full area and full height internal and external reforming fuel cell stacks.

The technical feasibility of molten carbonate fuel cells has been demonstrated in small stacks in laboratories. In FY 1987, research will continue to develop internal and external reforming fuel cell stacks. Efforts will also continue to develop improved components and corrosion resistant materials for molten carbonate fuel cells.

	FY 1986 Approp.	FY 1987 Request	Net Change
Advanced concepts	$ 3,770	$ 1,600	$ -2,170

The FY 1987 budget request will continue FY 1986 research activities at a reduced level of effort in the testing of a 5 kW module and the development of a 25 to 200 kW generator. No additional funding is requested beyond FY 1986 for the completion of system studies and research on solid oxide fuel cell materials. The private sector would be expected to assume a larger role in further development of solid oxide fuel cell concepts.

The objective of the advanced concepts program has been focused on the technology development and verification of solid oxide fuel cells. The solid oxide fuel cell is an advanced, high temperature ($1800^{o}F$) solid state fuel cell that offers promise in electric utility and in cogeneration applications (because of the high temperature) in industrial and commercial sectors. The program has been cost shared with the manufacturer.

In prior years, research and development efforts have focused on the fabrication and test verification of single cells and modules of 12 to 24 cells.

FY 1986 funds were utilized to continue technology development of a tubular solid oxide fuel cell concept including the fabrication and initial test of a 5 kW module and the initial design of a 25 to 200 kW generator.

The technical feasibility of solid oxide fuel cells have been demonstrated in small modules in laboratories. In FY 1987, efforts will be continued to develop solid oxide technology as well as critical materials research. Specifically, research efforts will continue the development of the 25 to 200 kW generator.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
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COAL
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(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 1/ Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Heat engines (FE)					
Operating expenses	$11,850	$12,314	$12,314	$ 7,942	$ -4,372
Subtotal	11,850	12,314	12,314	7,942	-4,372
Total					
Operating expenses	11,850	12,314	12,314	7,942	-4,372
Heat engines	$11,850	$12,314	$12,314	$ 7,942	$ -4,372
Staffing Total FTE's: Direct ...	6	7	7	6	-1
Indirect .	10	9	9	8	-1

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Heat Engines (FE)				
Operating Expenses	$12,886	$-69	$-503	$12,314
Subtotal, Heat Engines (FE) ..				
General Reduction:				
Operating Expenses	$ 69	69	-	-
Total, Heat Engines (FE)	$12,817	-	$-503	$12,314
Operating Expenses	12,817	-	-503	12,314

Summary of Changes

FY 1986 Appropriation enacted	$12,314
Program increases and decreases:	
Heat Engines	
o Continue research activities, at a reduced level, related to the FY 1985 PRDA for coal fired gas turbine major systems component development to provide selected integrated systems test validations by a target date of 1990-1992. Continue coal fired diesel engine component design and evaluation program and initiate research activities related to the FY 1986 PRDA for diesel engine integrated test validation	-4,372
FY 1987 budget request	$ 7,942

Heat engines:

Goals/Objectives:

The principal goal of this program is to establish technical data which will enable the private sector to assess the commercial viability of coal-fueled power conversion systems. The program focuses on key technical problems associated with substituting coal or coal-derived gaseous fuels for distillate fuels or natural gas in gas turbine and diesel power conversion systems. The program goal is to assist the private sector, through selected research efforts, to develop the technology needed for direct firing of coal, either dry or suspended in a liquid carrier, or a coal-derived gaseous fucl cleaned at minimal cost.

Specific program objectives are to:

- o Establish component design, fuel specification, and operating requirements for coal fueled gas turbine power systems and determine, through integrated systems tests, the commercial feasibility of selected system concepts in specific railroad, marine, industrial, or utility applications.
- o Establish basic design, combustion, materials, and fuel interactions and related engineering data to facilitate private sector assessment of commercial viability of coal-fired diesel systems through integrated systems tests.

FY 1986 Accomplishments:

- o Initiated research activities, at a reduced level, related to FY 1985 PRDA for coal fired gas turbine major system component development to provide selected integrated systems test validations by a target data of 1990-1992. The contracts to be structured so as to allow completion of specific portions of the work commensurate with available funds.
- o Continued economic and technical studies by diesel manufacturing firms of potential coal-fired diesel power systems in specific railroad or industrial service. Based on results, formulated general requirements for integrated engineering development of selected system concepts.
- o Established technical feasibility of slagging combustor design concepts and/or sorbent injection approaches to extract deleterious impurities from the combustion gases produced by selected coal fuels.
- o Completed report requested by Congress on feasibility of coal-fired locomotive.
- o Initiated PRDA for coal-fired diesel engine integrated systems test validations.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Heat engines	$12,314	$ 7,942	$ -4,372

The FY 1987 budget request will continue FY 1986 research activities at a reduced level of effort.

The Heat Engines program is directed towards major engineering design, durability, and performance problems associated with the substitution of coal or coal-derived fuels for distillate fuels and natural gas in gas turbine and diesel power conversion systems. This fuel substitution creates technical problems in both types of engines. In turbines, the durability of major components (i.e., combustors, transition ducts and turbine airfoils) are of concern. Similarly, the hostile environments created by firing coal-based fuels affect the durability of diesel engine components, particularly cylinder walls, pistons, valves and injectors. In addition, both applications require adjustments of combustion component design and conditions to suppress NO_x emissions and to ensure efficient combustion of coal-based fuel.

Activities under the Gas Turbine Program are being coordinated and directed towards definitive integrated systems testing, targeted for the 1990-1992 time period. Major component design, development, and integrated test evaluation will be conducted by qualified industrial contractors. Essential engineering research and analytical support relating to fuel specifications, design analyses, environmental concerns, and quality control considerations are being carried out in DOE and national laboratories or by qualified university and private sector research organizations. Coal-derived gaseous fuels, coal-liquid slurry fuels, and dry powdered coal are all being evaluated under the program. The integrated systems tests are expected to provide a firm basis for private sector commercial development of power systems for such applications as railroad locomotives, industrial cogeneration, or utility combined cycle power generation.

The Diesel Program is planned similarly to reach the integrated systems test phase in the 1992-1994 period. Following preliminary analytical studies and experimental feasibility testing, major diesel manufacturers will be solicited to competitively or cooperatively develop and test, integrally, essential power system components. Supporting activities will be conducted in a manner similar to the gas turbine approach. The program aims toward eventual rail locomotion and industrial cogeneration applications.

FY 1987 anticipated accomplishments include:

- Continue combustion tests in the gas turbine combustor test stand to determine combustion characteristics of various fuels and the establishment of preliminary coal fuel specification.
- Continue combustion and wear tests utilizing coal liquid mixtures in the new "in-house" diesel engine test facility at METC.
- Initiate research activities related to the FY 1986 PRDA for the coal-fired diesel engine integrated systems test validation.
- Complete preliminary coal-fueled testing of diesel test facility components including fuel injection system, combustion chamber, and piston assemblies.
- Complete engineering tests to determine the feasibility of slagging combustors and sorbent additions.
- Complete first portion of the coal-fired gas turbine integrated systems test validation program.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those

who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

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COAL
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(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Underground coal gasification (FE)					
Gasification technology development:					
Operating expenses	$ 3,098	$ 2,352	$ 2,352	$ ...	$ -2,352
Subtotal	3,098	2,352	2,352	...	-2,352
Environmental and advanced research:					
Operating expenses	2,607	1,720	1,720	...	-1,720
Subtotal	2,607	1,720	1,720	...	-1,720
Total					
Operating expenses	5,705	4,072	4,072	...	-4,072
Underground coal gasification	$ 5,705	$ 4,072	$ 4,072	$ ...	$ -4,072
Staffing Total FTE's: Direct	0	0	0	0	0
Indirect	13	9	9	0	-9

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Underground Coal Gasification (FE)				
Gasification Technology Development Operating Expenses	$2,460	$-12	$-96	$2,352
Environmental and Advanced Research Operating	1,800	-10	-70	1,720
Subtotal, Underground Coal Gasification (FE)	4,260	-22	-166	4,072
General Reduction: Operating Expenses	-22	22	-	-
Total, Underground Coal Gasification (FE)	$4,238	-	$-166	$4,072
Operating Expenses	4,238	-	-166	4,072

Summary of Changes

FY 1986 Appropriation enacted	$ 4,072
Program increases and decreases:	
Gasification Technology Development	
o Phase out technology base activities and initiate applied research under the cooperative R&D venture pool	-2,352
Environmental and Advanced Research	
o Phase out technology base activities and initiate applied research under the cooperative R&D venture pool	-1,720
FY 1987 budget request	$ ...

Underground coal gasification:

Goals/Objectives:

Underground Coal Gasification (UCG) is a process for converting coal, in place (in situ), to a readily cleanable synthetic gas comparable to that produced from surface gasification systems. The energy for the process is derived from partial combustion of the coal (pyrolysis) resulting in the identical reactions that occur in aboveground gasification. The process is being developed to address the coal resources considered unminable for either economic or technical reasons, e.g., steeply dipping, high ash, deeply buried, or high sulfur coals. Advantages of the technology include low front end capital requirements, short lead time required to establish a plant in operation, relative freedom from the usual economies-of-scale considerations, utilization of less desirable coals, the ability of the process to convert all the sulfur in the coal to readily removable "acid-gas" (Hydrogen sulfide), and the ability to produce a wide variety of end use products. As to the latter, gasification with air produces a low Btu gas (100-175 Btu/SCF) suitable for power generation or industrial heat while gasification with an injection mixture of steam and oxygen produces a medium Btu gas (175-350 Btu/SCF) either for the same uses or as a chemical feedstock for the production of methanol, ammonia, or for upgrading to a suite of products.

A series of tests at varying scale have been conducted over the past several years on UCG. The process was essentially proven for steeply dipping (greater than 35 degrees) shrinking subbituminous coals through a cost shared field development program with the Gulf R&D Company. Some questions remain regarding application of UCG to flat lying subbituminous coals prior to an industry takeover of the final stages of development. Answers essential to this next step along the R&D path are being sought through a three year program begun in FY 1985. These technology base activities will be completed in FY 1987. Application of UCG to bituminous coals represents a greater technological challenge primarily because it swells and tends to choke off gas flow required to link injection and production wells. In addition, bituminous coals usually occur in thinner seams which present a more difficult drilling and linking target and compound thermal losses during operation. Preliminary testing has proven encouraging, however, and Peabody Coal Company (with support from the State of Illinois) has agreed to participate in a cooperative program to explore the potential of UCG in bituminous coals at a site in southern Illinois. Paralleling the subbituminous and bituminous process research is an environmental program concerned primarily with preventing or predicting and mitigating the effects of aquifer contamination and subsidence. Empirical models developed for subsidence prediction appear adequate at this time but an understanding of aquifer contamination mechanisms and mitigation or clean up measures must be developed if UCG is to be deemed an environmentally acceptable technology. The approach will be to address these issues in concert with planned cooperative ventures. Also, there is need to perform certain monitoring activities at previous test sites to comply with Federal and state laws (funding requirements in this regard are declining as sites are declared acceptable and abandoned).

Because of the inherent advantages of UCG discussed above, there is a high degree of international interest in the technology. This interest has allowed us to leverage our resources through cooperative programs with two countries to date: (1) We have an agreement with Brazil to collaborate on planned developments there with the U.S. receiving data from field tests; and (2) We have received approval and funding from the U.S./Spain Joint Science and Technology Committee for a joint research project with Spain which will provide valuable data on bituminous UCG. Other countries have expressed a desire to work with DOE. This interest will be aggressively pursued under the cooperative R&D venture pool.

The major objectives of this program are the following:

- o Pursue the development of environmentally acceptable in situ technologies for converting coals which are unattractive to mine into clean liquid or gaseous fuels.
- o Demonstrate the viability of producing medium-Btu gas from low-rank coals utilizing steam/oxygen, to provide a suitable feedstock for surface upgrading and/or combustion.
- o Test the viability of underground gasification of low to moderate swelling, bituminous coals.
- o Increase the data base to support private sector development of economically viable in situ conversion processes.
- o Work actively with industry to ensure maximum technology transfer.
- o Actively seek opportunities to leverage project funds for process development activities through cooperative projects with industry and with foreign research and development groups studying UCG.

FY 1986 Accomplishments:

FY 1986 accomplishments include:

- o Completed second year of a three year effort to establish a technology base for application of UCG to subbituminous coals sufficient to launch industrial process development.
- o Completed a series of large-block tests on WRI's large laboratory reactor to test feasible concepts and determine operating mechanisms in support of the field programs.
- o Completed necessary monitoring data receipt and advising as needed in cooperating with early UCG efforts in Spain, Brazil, India and Yugoslavia.
- o Completed essential post-burn monitoring and evaluation of past UCG test sites.
- o Completed on-going laboratory and test site research directed toward aquifer restoration methods and contaminant mitigation procedures along with the completion of a predictive model for migration of potential contaminants after operation and development of a plan for aquifer clean-up if this should prove necessary.
- o Completed further development of process models to assist industry in plans for follow-on development of the processes.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Gasification technology development	$ 2,352	$ ...	$ -2,352

No funds are requested in FY 1987 for this program. A three year effort initiated in FY 1985 to develop a technical data base requisite to industrial process development will be concluded using previously appropriated funds. Follow-on research and development activities will be pursued through potential cooperative ventures with industry.

Environmental and advanced research	$ 1,720	$ ...	$ -1,720

The reduction in funding from the FY 1986 level reflects completion of environmental data base development activities in part through the three year program discussed above

and through parallel laboratory and field testing conducted by the Lawrence Livermore National Laboratories and the Western Research Institute.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Magnetohydrodynamics (FE)					
Proof-of-concept topping cycle:					
Operating expenses	$18,344	$18,302	$18,302	$ ...	$-18,302
Subtotal	18,344	18,302	18,302	...	-18,302
Proof-of-concept bottoming cycle:					
Operating expenses	8,500	8,024	8,024	...	-8,024
Subtotal	8,500	8,024	8,024	...	-8,024
Proof-of-concept seed regeneration:					
Operating expenses	600	388	388	...	-388
Subtotal	600	388	388	...	-388
System studies and supporting research:					
Operating expenses	3,277	1,003	1,003	...	-1,003
Subtotal	3,277	1,003	1,003	...	-1,003
Total					
Operating expenses	30,721	27,717	27,717	...	-27,717
Magnetohydrodynamics	$30,721	$27,717	$27,717	$ ...	$-27,717
Staffing Total FTE's: Direct	0	0	0	0	0
Indirect	12	0	0	0	0

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Magnetohydrodynamics (FE)				
Operating Expenses	$29,000	$-150	$-1,133	$27,717
Subtotal, Magnetohydrodynamics (FE)	$29,000	$-150	$-1,133	$27,717
General Reduction: Operating Expenses	-150	150	1,133	-
Total, Magnetphydrpdynamics (FE)	$28,850	-	$-1,133	$27,717
Operating Expenses	28,850	-	-1,133	27,717

Summary of Changes

FY 1986 Appropriation enacted	$27,717
Program increases and decreases:	
Magnetohydrodynamics	
o Terminate the MHD program	-27,717
FY 1987 budget request	$ ...

Magnetohydrodynamics:

Goals/Objectives:

The Department believes that the cost of continuing its MHD program is not affordable in light of current fiscal constraints and has reassessed its priorities for fossil energy technologies and determined that other technologies could contribute more directly to DOE's objectives with lower investment requirements, in a more timely manner, and with significantly more cost-sharing. We believe that the private sector interests that have promoted MHD are in a position to continue to develop MHD technology based on the Federal Government's efforts to date. The private sector can continue the MHD program with an-in-kind contribution by the Government of facilities and equipment valued at approximately $120 million.

FY 1986 Accomplishments:

- o Completed eight-hour (nominal) integrated combustor-channel power generation test at the CDIF.
- o Completed testing of baghouse and electrostatic precipitator at the CFFF.
- o Awarded cost-shared seed recovery/regeneration contract and initiated bench-scale testing.
- o Awarded cost-shared contract for feasibility and conceptual design study of a coal-fired MHD retrofit.
- o Awarded cost-shared contract for an integration/mission contractor.
- o Awarded cost-shared contract for a prototypical 50MW (thermal) coal-fired combustor.
- o Awarded cost-shared contract for a prototypical long-duration channel.

Budget Request:

	FY 1986 Approp.	FY 1987 Request	Net Change
Magnetohydrodynamics	$27,717	$ ...	$-27,717

The Department requested no funding in FY 1986 assuming that the MHD program would be terminated in FY 1985. However, Congress overturned the Department's proposed FY 1985 deferral stipulating in the Conference Report of July 2, 1985, that "the managers expect the MHD community to develop and submit to the appropriate Congressional committees a plan for significant industry cost-sharing which would include increasing commitments above existing levels. The new cost-sharing plan should be based on the MHD development plan submitted by the Department to Congress in June 1984. Additional funds should not be appropriated absent increased cost-sharing."

Bill language for FY 1986 provides $28,850,000 to fund a cost-shared, multi-year MHD program. The costs of fabricating equipment to be tested in the Government-owned facilities are to be included in the amounts that require cost sharing. The costs of installing and testing equipment are not to be subject to cost sharing.

No funds are requested for FY 1987. The transition of the MHD program activities from the Congressionally directed FY 1986 activities to termination will be addressed as part of subsequent FY 1986 budget proposals. It is anticipated that the large amount of

equipment and facilities having significant value and owned by the Government can be made available to private industry in a manner that will allow industry to continue the development of the technology consistent with their interests and funding availabilities.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Surface coal gasification (FE)					
Advanced research:					
Operating expenses	$ 3,364[2/]	$ 3,379	$ 3,379	$ 968	$ -2,411
Subtotal	3,364	3,379	3,379	968	-2,411
Advanced process development:					
Operating expenses	4,376	5,229	5,229	1,689	-3,540
Subtotal	4,376	5,229	5,229	1,689	-3,540
Systems engineering concepts:					
Operating expenses	20,878	27,949	27,949	1,373	-26,576
Subtotal	20,878	27,949	27,949	1,373	-26,576
Environmental and engineering analyses:					
Operating expenses	3,516	2,113	2,113	1,131	-982
Subtotal	3,516	2,113	2,113	1,131	-982
Great plains coal gasification project:					
Operating expenses	3,000	2,653	2,653	437	-2,216
Subtotal	3,000	2,653	2,653	437	-2,216
Total					
Operating expenses	35,134	41,323	41,323	5,598	-35,725
Surface coal gasification .	$35,134	$41,323	$41,323	$ 5,598	$-35,725
Staffing Total FTE's: Direct ...	20	23	23	18	-5
Indirect .	41	37	37	43	+6

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

2/ Gasification processes ($3.364M) transferred to this activity from the Advanced Research and Technology Development activity.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Gramm-Rudman-Hollings	Total
Surface Coal Gasification (FE)				
Advanced Research Operating Expenses	$ 3,535	$-18	$-138	$3,379
Advanced Process Development Operating Expenses	5,472	-29	-214	5,229
Systems Engineering Concepts Operating Expenses	29,243	-152	-1,142	27,949
Environmental and Engineering Analyses Operating Expenses	2,212	-13	-86	2,113
Great Plains Coal Gasification Proj. Operating Expenses	2,775	-14	-108	2,653
Subtotal, Surface Coal Gasification (FE)	$43,237	$-226	$-1,688	$41,323
General Reduction: Operating Expenses	-226	226	-	-
Total, Surface Coal Gasification (FE)	$43,011	-	$-1,688	$41,323
Operating Expenses	43,011	-	-1,688	41,323

Summary of Changes

FY 1986 Appropriation enacted	$41,323
Program increases and decreases:	
Advanced Research	
o Complete advanced research in the areas of gas separation techniques and kinetics of coal gasification. Reduce research in the areas of fundamental chemistry and reaction mechanisms, and the chemistry of ash and slag from gasifiers	-2,411
Advanced Process Development	
o Redirect effort to focus only on the support of those studies specifically generating data required to establish the feasibility of advanced and novel techniques leading to the use of coal gasification technology in the generation of alternate energy options from coal	-3,540
Systems Engineering Concepts	
o Complete all efforts on projects that are being supported to generate reliability, availability and maintainability (RAM) and proof-of-concept (POC) data. In addition, redirect all studies that are considered to be engineering development efforts by nature	-26,576
Environmental and Engineering Analyses	
o Conclude all projects now being supported in waste water management and in the generation of data on other environmental aspects of coal gasification that are either available through the judicious extrapolation of the data base or which are or will be generated through the operation of existing coal gasification facilities (e.g., Great Plains Coal Gasification Plant, Cool Water, Dowsyn, Kilngas, etc.)	-982
Great Plains Coal Gasification Project	
o Reduce monitoring and management activities	-2,216
FY 1987 budget request	$ 5,598

Surface coal gasification:

Goals/Objectives:

The coal resource base of the United States is the largest single potential source of alternate hydrocarbon liquids and gases available to resolve anticipated energy supply problems of the Nation. As a heterogeneous SOLID feedstock, the full potential of this resource can be achieved only if it can be converted into useable alternate LIQUID AND GASEOUS energy products and chemical feedstocks.

The role that the Surface Coal Gasification Program serves in accomplishing the goals and objectives of the Office of Fossil Energy and the Department of Energy is to develop the full capabilities of coal gasification technology as a means of converting coal into those alternate energy forms that do create options for almost every sector of the energy consuming marketplace.

The research approach to the development and use of the most appropriate, efficient, and advanced concepts suitable for use in accomplishing that goal recognizes and accommodates the wide range in requirements of that marketplace. While that marketplace requires an almost unlimited number of coal gasification systems to respond to the specific needs of the consumer, (the availability of resource type, specific site requirements, etc.), the research and development program recognizes that each of these many systems can be grouped into one of several major classes. These classes include

systems for the production of power, industrial fuel gas, synthesis gas and coproducts or new fuels. The advances in the technology required to formulate and use these systems are being developed in research and development projects that are considered to be long-range and high-risk with objectives particularly suited to resolving the major issues and problems encountered in developing new promising alternatives for each of the separate processing units of these systems. Included among these units are feedstock modification, gasifier performance, particulate removal and heat recovery, acid gas removal and composition control, as well as fuel conversion and product upgrading. Completion of these activities will create the maximum number of options by which the energy consuming marketplace can use coal to fill its energy requirements.

In these activities R&D efforts are now focused on the acquisition of data leading to a further understanding of the gasification process and the functional links between that process and the operational parameters that will permit:

- o the state of the technology to remain current with those advances being made in associated fields and to be responsive to any advanced processing system designed to accommodate a changing market for fuels
- o development of any new concepts that appear to be 'break throughs' which have significant potential to improve the technology or contribute to its application in generating energy supply options
- o confirmation of the chemistry, kinetics and thermodynamics of the gasification process required to confirm, extend and apply advanced concepts leading to a fuller utilization of the total flexibility of the process

Successful completion of these activities will achieve the two major goals of the Surface Coal Gasification program.

These specific program goals which have been established to insure that the program creates options responsive to the requirements of those sectors of the U.S. economy that can use the technology to generate alternate energy products from coal are:

- o Advance the state-of-the-art of Surface Coal Gasification technology to optimize its potential for development of more viable or advanced gasification systems through the study of promising long term, high risk concepts that have significant potential to:
  - increase overall system efficiency
  - reduce capital costs
  - reduce system operating costs
  - reduce facility construction time
  - increase plant availability
  - reduce to a minimum the potential for any environmental impact caused by these facilities.

- o Identify and support those R&D efforts that will make available the full capabilities and processing flexibility of surface coal gasification systems as the key coal conversion technology directly applicable for generating alternative energy options from coal for every sector of the energy consuming marketplace.
- o Continue management and monitoring of the Great Plains Gasification Demonstration Project as necessary.

FY 1986 Accomplishments:

- o Completed slip stream testing studies.
- o Completed the cooperative operational program investigating reliability, availability, and maintainability (RAM) characteristics of the Allis-Chalmers KILnGAS Coal Gasification Demonstration Facility.
- o Completed a cooperative program investigating the pressurized ash agglomerating fluidized-bed coal gasification integrated system for combined cycle electric power production or other industrial uses (including hot gas cleanup and hot particulate removal as part of the integrated system).

- Continued to provide engineering analyses and systems evaluation as required to support activities of the joint DOE/GRI Coal Gasification Program.
- Completed testing of the CO_2 triple point crystallizer and sulfur absorber sections of the liquid CO_2 gas cleanup system.
- Concluded the electroslag component casting project and demonstrated its capability for producing high quality, low cost equipment castings.
- Concluded the instrumentation project for measuring gas stream alkali particulates composition.
- Concluded the atomic absorption instrumentation project for measuring gasifier product gas stream composition.
- Completed an entrained flow data book.
- Completed multicomponent equilibrium studies, pressure-swing adsorption studies, and modeling for cyclic separation of gases using coal based sorbents.
- Concluded studies on environmental aspects of coal gasification to include waste water management, effluent control systems, and impact of gasification plant environments on worker health.
- Completed studies of novel approaches to usage of micro-organisms for removal of trace amounts of organic contaminants in waste water.
- Completed a study on hybrid gasification reactors that use flexibility and advantages of different designs to maximize coproduct yields for specific industrial applications.
- Concluded studies of integrated gasification systems to provide the data needed to predict optimized configuration for various product yields.
- Completed reactivation of fixed-bed gasification PDU at METC.
- Completed studies on performance of fixed-bed gasifier, hot gas cleanup unit and turbine test stand during integrated operation under dynamic as well as steady state operating conditions.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Advanced research	$ 3,379	$ 968	$ -2,411

The objectives of the Advanced Research (AR) gasification studies include investigations on: (1) new fundamental concepts about coal structures and the physical and chemical mechanisms whereby these structures undergo devolatilization and gasification; (2) mathematical models, based on fundamental principles, which can be used to predict and simulate behavior of gasification and other subsystems under new conditions; (3) laboratory scale experimental and analytical studies of the chemistry and fluid dynamics of ash and slag in various gasification systems; and (4) novel gas separation and gas cleanup processes which have the potential for providing technical and economic advances in gas separation technology.

The following accomplishments are representative of progress expected in FY 1986:

- Advances will be made towards completing a mathematical model that can be used to predict gasification product yields and rates as a function of the chemical structure of coal.
- A novel ion exchange membrane technique will be applied to demonstrate the separation of acid gases from the gasification products.
- A fundamental investigation will be conducted on the use of supported metal complexes as an efficient gas separation method.
- A fundamental investigation of biological approaches to coal conversion will be started.
- New catalyst systems for low temperature water gas shift reactions will be developed for more efficient control of product gas compositions, e.g., low-cost hydrogen production.

The FY 1987 request of $968,000, is a reduction of $2,411,000 from the FY 1986 funding level. This will result in a completion in FY 1986 of all research relating to novel

gas separation techniques; and kinetics of coal gasification and devolatilization, including the development of models and experimental verification. In FY 1987, research will continue at a reduced level in the areas of fundamental chemistry and reaction mechanisms associated with mild gasification; and the chemistry of ash and slag from gasifiers.

	FY 1986 Approp.	FY 1987 Request	Net Change
Advanced process development	$ 5,229	$ 1,689	$ -3,540

The FY 1987 request for funds represents a reduction of $3,540,000 from the FY 1986 appropriations. This reduced funding is consistent with a redirection of these activities. This redirected effort now focuses on the support of studies specifically generating data required to establish the feasibility of advanced and novel techniques particularly suited for the application of coal gasification technology in the generation of alternate energy options from coal.

The major objectives of the activities being performed in advanced process development is the generation of a comprehensive technology data base needed for new gasifier concepts. Basic programs involving kinetics and fluid dynamics, thermochemistry and other fundamental concepts including advanced, sophisticated process chemistries, are all part of these high-risk, long-range research projects which have the potential for high payoff upon the successful completion of the experimental work.

In FY 1986, the Advanced Gasification Test Facility was operated and additional data was gathered and evaluated to conclude the development of advanced instrumentation concepts, the development of advanced gas cleanup devices and to define some of the basic concepts of coal gasification in entrained reactors. Innovative techniques (e.g., mild gasification) that have the potential to either increase gasifier yields or dramatically affect the comparative distribution of products produced during the gasification process were further explored and advances were made in gasifier development and application studies, when advanced, new feedstocks (e.g., pulverized, deep cleaned, coal-carbon dioxide mixtures) were used in short residence time, high rate gasifiers. The resulting products were used to develop techniques for the identification of improved processing concepts for increasing their range, and suitability as well as in reducing the cost of utilizing minimally treated pyrolysis products of coal for alternate fuels in advanced energy conversion systems.

Efforts were continued to examine the behavior of fluidized beds when operating under conditions of high temperature and high pressure and to examine the concept of using semi-volatile catalysts within the gasifier itself. These data along with other thermophysical property characteristics of liquid and gaseous mixtures were also used to verify a number of advanced gasifier/gasification process models.

In FY 1987, those efforts performed in FY 1986 to develop innovative techniques with the potential to either increase gasifier yields or dramatically affect the comparative distribution of products generated (i.e., gases, liquids, solids) during the gasification process will be evaluated and the most promising approaches used as a basis for continuing these studies. In addition, studies will be performed to identify and apply new techniques for the application of promising catalyst systems directly to coal as a feedstock or for use within the gasifier itself. The objective of this work will be to realize the potential that exists through this approach to significantly improve system processing flexibility, increase product yields and reduce costs.

Efforts will also continue on studies using coal based sorbents and zeolites in pressure swing adsorption for separation of gases as well as for the development of low cost permeable membranes for hydrogen separation. Studies on the characterization of char during devolatilization will be continued and studies on advanced staged, concurrent rapid rate reactors will be completed. Finally, theoretical studies on coal gasifiers and gasification systems will also be continued.

	FY 1986 Approp.	FY 1987 Request	Net Change
Systems engineering concepts	$27,949	$ 1,373	$-26,576

The reduced level of funding requested for these activities in FY 1987, representing a reduction of $26,576,000 from the FY 1986 appropriation, is the direct result of completing several Proof-of-Concept (POC) and Reliability, Availability and Maintainability (RAM) studies in process development unit (PDU) and demonstration sized gasifiers as well as redirecting some studies away from engineering development efforts.

In general, the work being performed within the category of Systems Engineering Concepts is directed toward the continued development of integrated gasification systems, optimization of concepts for specific applications and achieving the full flexibility of the technology in generating the maximum number of alternate fuel forms from coal. With the completion of the PDU efforts, these studies will focus on the potentially promising concepts that are of a high-risk but which can generate data of direct support to the application of these gasifier systems.

In FY 1986, the evaluation and analysis of operational data that demonstrated the flexibility of the agglomerating ash, fluidized-bed gasification concept was completed. The problems that must be resolved to operate simplified integrated modular gasification systems (gasifiers, hot gas cleanup, particulate removal, etc.) for combined cycle power production were studied. Data generated during these efforts were essential in creating the incentives needed for industry to consider the continued development of such systems. These studies also provided the industrial sector with the data needed to evaluate the use of the ash agglomerating fluidized-bed gasifier for the production of power to convert all types of coal into alternate forms of gas and liquid fuels as well as chemical feedstocks. Work was also completed on the performance testing of the KILnGAS gasification facility. These studies generated significant amounts of data on the Reliability, Availability and Maintainability (RAM) characteristics of the concept of coal gasification. These data were required by the utility and industrial sectors to evaluate the potential and suitability of this concept for use in specific end-use applications. In addition, evaluation and development efforts on a hybrid gasifier concept being considered in the evaluation of new systems capable of optimizing the product yield for specific industry applications were completed. The component and instrumentation part of the systems engineering concepts effort was completed. The successful development of these system enhancement projects have generated data required in the design and construction of more economic and viable coal gasification facilities.

In FY 1987, the cooperative effort with the Gas Research Institute will continue with specific studies and engineering analyses performed on projects of interest to the joint objectives of the combined program. The fixed-bed gasifier at the Morgantown Energy Technology Center will be operated with the experimental emphasis on new methods of obtaining high percentage in situ and/or external sulfur removal to enhance the use of fixed-bed gasifiers using advanced hot gas cleanup concepts. The gasifier will be used to generate a source of "dirty" fuel gas for testing hot particulate removal and chemical and physical gas cleanup devices and the initial steps will be taken to identify and resolve the integration issues associated with the evaluation of a system suitable for the production of new fuels. The fundamental mechanisms leading to a determination of the potential of the zirconia solid state oxygen separator as an alternative to the very expensive cryogenic methods of producing oxygen also will be studied.

Environmental and engineering analyses	$ 2,113	$ 1,131	$ -982

The FY 1987 request for funds represents a reduction of $982,000 from the FY 1986 appropriation for this same activity. The reduced level of funding reflects the maturity of the data base for surface coal gasification in the area of environmental concern. Investigative studies on all aspects of coal gasification and its possible

impact on the environment resulting from any siting activity mining effort, operation, effluent discharge, product preparation and distribution, etc., have been in progress for many years. These studies have been performed in gasification activities that range from bench scale through the demonstration-sized plant and have generated a very strong and comprehensive environmental data base. A continuing assessment of this data base will be performed to identify any omissions and to focus attention on any areas requiring further study.

Those projects required to generate any additional data, resolve any remaining issues and to develop the technology required to reduce to a minimum any potential environmental impact associated with the implementation of any gasification system on a commercial scale are included as part of this activity.

In FY 1986, studies performed to understand the environmental aspects of each of the processing units as well as the total integrated coal gasification process itself were performed. Enough data were generated to confirm the value of simulation models in making comparative evaluations of promising effluent management techniques and to evaluate "zero discharge" waste water management schemes. Promising results were obtained from studies performed to investigate the application and use of biological micro-organisms in the clean-up of trace organic contaminants in quench and process liquids. The ASPEN process model was demonstrated to be an effective tool for evaluation storage and usage of a wide range of gasification environmental data. Considerable amounts of environmental data were obtained from the operation of the Great Plains Coal Gasification Plant (GPCGP). These data were evaluated and entered into the data base. Work was continued on the compilation, assessment and correlation of the design data produced during DOE's support of the feasibility design and demonstration plant program. The processed data was entered into the gasification technology data base. As part of this effort, a number of gasifier operational codes that had been under development for a number of years by several firms were evaluated, made compatible and entered into the software library available to process modeling activities.

In FY 1987, work will be performed to investigate process modifications in a coordinated effort with downstream cleanup work in fluidized and fixed-bed gasification systems required to reduce the generation of trace hazardous compounds. During the year, the results obtained during the operation of the GPCGP will be used to determine relationships between operational parameters, process efficiency and environmental impact. Earlier trends established at the bench-scale and supported at the PDU/pilot plant level will be compared with full commercial data to identify discrepancies, generate correlations and to identify areas of inadequate information (i.e., data needs). Finally, a study to investigate the fate of trace metals, hydrocarbons and alkalis during the generation and combustion of gaseous fuels from coal will be performed using laser-induced fluorescence instrumentation. These data are essential in developing and utilizing hot gas cleanup systems.

	FY 1986 Approp.	FY 1987 Request	Net Change
Great plains gasification project	$ 2,653	$ 437	$ -2,216

The funding request for the Great Plains Gasification Project (GPGP) in FY 1987 has been reduced by $2,216,000 below the amount of funds appropriated in FY 1986. This reflects a reduction in contract support of DOE's monitoring and management activities.

In FY 1986, the DOE's monitoring and management activities of the project were performed by the Acting Assistant Secretary for Fossil Energy, the Office of Oil, Gas, Shale and Coal Liquids, the Chicago Operations Office, the Grand Forks Project Office and the Morgantown Energy Technology Center.

On August 1, 1985, the Great Plains Gasification Associates partnership notified the government that their consortium intended to abandon the North Dakota facility and default on the $1.5 billion federal loan it received to build the plant. The Department

is presently studying sale or lease options for the future operation of this facility. The Department's request is to be utilized in the continued direction and monitoring of the Great Plains project.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

FOSSIL ENERGY RESEARCH AND DEVELOPMENT

PETROLEUM RESEARCH AND DEVELOPMENT

VOLUME 6

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FY 1987 CONGRESSIONAL BUDGET REQUEST
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PETROLEUM
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Advanced process technology (FE)					
Advanced exploratory research:					
Operating expenses	$ 4,380	$ 4,486	$ 4,486	$ 1,576	$ -2,910
Subtotal	4,380	4,486	4,486	1,576	-2,910
Arctic and offshore research:					
Operating expenses	984	1,037	1,037	235	-802
Subtotal	984	1,037	1,037	235	-802
Total					
Operating expenses	5,364	5,523	5,523	1,811	-3,712
Advanced process technology	$ 5,364	$ 5,523	$ 5,523	$ 1,811	$ -3,712
Staffing Total FTE's: Direct ...	0	0	0	0	0
Indirect .	16	15	15	5	-10

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Conference	General Reduction	G-H-R Reduction	Total
Advanced process technology (FE)				
Advanced exploratory research:				
Operating expenses	$4,692	$-23	$-183	$4,486
Subtotal				
Arctic and offshore research:				
Operating expenses	1,086	- 7	- 42	1,037
Subtotal, Advanced Process Technology	5,778	-30	-225	5,523
General Reduction:				
Operating Expenses	-30	30	-	-
Total, Advanced Process Technology	$5,748	-	$-225	$5,523
Operating Expenses	5,748	-	-225	5,523

Summary of Changes

FY 1986 Appropriation enacted	$ 5,523
Program increases and decreases:	
Advanced Exploratory Research	
o Complete ongoing extraction technology research and terminate the development of advanced instrumentation	-520
o Complete ongoing fuels testing research and identification of processing needs activity and suspend further work	-883
o Reduce activities in extraction related studies on subsidence and aquifer contamination and suspend further work	-514
o Complete ongoing MEOR technical feasibility analysis studies	-566
o Reduce activities in fundamental petroleum chemistry, thermodynamics, geoscience, and physical properties of petroleum and synthetic crudes	-427
Subtotal	-2,910
Arctic and Offshore Research	
o Reduce activities in Arctic energy data base development and maintenance	-604
o Complete ongoing fundamental ice research	-198
Subtotal	-802
FY 1987 budget request	$ 1,811

Advanced process technology:

Goals/Objectives:

The Advanced Process Technology (APT) program serves the dual purpose of exploring new concepts with the potential to achieve quantum increases in efficiency and significant cost reduction of recovery techniques for oil, gas, and oil shale and to conduct fundamental research that is relevant to oil, gas, and oil shale recovery, where the experimental procedure, method being developed, or item of concern is more important than the resource being investigated.

There are two goals within the APT Program. These are:

- o To pursue the fundamental research relevant to oil, gas, and shale recovery, i.e., development of the tools and techniques to measure and predict important properties and phenomena, and to obtain the fundamental data critical to these recovery processes.
- o To provide the proper environment to conduct research and to pursue application of new frontiers of science and/or as yet unexplored new concepts to achieve quantum increases in recovery efficiency for oil, gas, and shale resources.

During the APT program planning process, an evaluation of the needs of oil, gas, and shale technologies is conducted. Based on this evaluation a prioritized list of research needs is compiled according to the potential crosscut benefits to oil, gas and shale programs.

As to the second goal of the APT program, the intent is to evaluate new methods of resource extraction that offer the potential for very significant increases in energy efficiency, more favorable economics, or environmental benefits. Emphasis is placed on soliciting ideas from outside the Department of Energy in order to assure that the program takes advantage of the best ideas that the nation and international sources have to offer. After the feasibility of the idea has been determined it can then be transferred to the relevant technology program for development or if warranted the

research may be terminated. An example of this transfer process is the microbial enhanced oil recovery (MEOR) thrust prior to FY 1987. It was under the auspices of the APT program where it was determined that the method appears feasible and warrants an increased research effort. Thus in FY 1987 MEOR is being transferred to the Enhanced Oil Recovery program for implementation.

FY 1986 Accomplishments:

FY 1986 accomplishments include:

- Complete technical feasibility analyses conducted by four universities and define a program of research addressing research needs requisite to applying microbial EOR in a production mode.
- Continue fundamental petroleum chemistry research focusing on physical and chemical characterization studies of heavy oil; thermodynamic measurements; shale oil and tar sands bitumen studies and fuel storage and handling.
- Complete ongoing extraction technology research focusing on reservoir characteristics and advanced instrumentation development.
- Complete ongoing fuels testing research, correlation of fuels composition and processing needs, and predictive models relating process to composition.
- Continue ongoing extraction related studies which will focus on the mitigation of aquifer damage and subsidence problems.
- Continue the update and maintenance of the Arctic/offshore oil and gas research data base.
- Complete ongoing fundamental ice research to characterize size, composition, degree of consolidation, temperature and salinity profiles.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Advanced exploratory research	$ 4,486	$ 1,576	$ -2,910

The reduction of $2,910,000 from the FY 1986 funding level reflects a focusing of research at the National Institute for Petroleum and Energy Research and discontinuation of university and national laboratory efforts in geoscience, chemical EOR, and reservoir diagnostics. All efforts conducted in FY 1986, with the exception of fundamental petroleum, geoscience, acquifer contamination, and chemistry research were completed. More specifically, in FY 1986, activities in microbial enhanced oil recovery were brought to a close in regard to investigating the technical feasiblity of the concept. A program was developed to define research needs that must be addressed prior to application of microbial enhanced oil recovery in a production mode. The National Institute for Petroleum and Energy Research (NIPER) continued a program of research to establish the chemical, physical and thermodynamic properties of heavy oil and syncrude feedstocks essential to defining problem compounds and properties requisite to introducing them into the present infrastructure; and developing analytical models correlating alternate crude/fuel composition to processing and utilization (combustion properties). Also a planned 3-year university/industry research effort in support of geosciences and chemical flooding related to enhanced oil recovery (initiated under a FY 1985 PRDA) was brought to completion in FY 1986 as were national laboratory efforts to develop diagnostics to measure key reservoir parameters in-situ.

In FY 1987, research will continue at NIPER in fundamental chemistry, physics and thermodynamics on heavy petroleum, tar sands bitumen, and oil shale feedstocks in an attempt to focus efforts and benefit from the government/industry interface available through this institution. Included in this research will be the development of more practical analytical tools and techniques for the analysis of the heavier ends. Under the joint U.S./Venezuela agreement, work will continue on the characterization of heavy crude oil. This effort was redirected during FY 1986 to emphasize developing the improved means of characterization rather than continuing to determine the properties of specific crudes, such as the Venezuelan Cerro Negro heavy oil. Under the joint U.S./ Israel agreement, work will continue on the chemical aspects of acquifer contamination.

	FY 1986 Approp.	FY 1987 Request	Net Change
Arctic and offshore research	$ 1,037	$ 235	$ -802

In FY 1986, efforts continued in establishing consolidated, coordinated, central arctic oil and gas research information and data base systems as recommended in a National Petroleum Council study on arctic development. This study identified the need for a coordinated energy related information/technology data system where the myriad of industry, academia and government agencies could access and input information. Research was also conducted to establish the characteristics of the ice islands and ice ridges which pose a hazard to offshore structures.

In FY 1987, an annotated bibliography relevant to energy development will be prepared; the key element of the Arctic and Offshore Research Information System will reflect the state-of-the-technology as of FY 1987. All other planned technology base activities will be suspended or be the subject of a cooperative R&D venture pool project, e.g., cooperative work with the State of Alaska and Arctic Ocean rim countries.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
PETROLEUM
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 1/ Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Enhanced oil recovery (FE)					
Heavy oil:					
Operating expenses	$ 2,557	$ 2,756	$ 2,756	$ 608	$ -2,148
Subtotal	2,557	2,756	2,756	608	-2,148
Light oil:					
Operating expenses	7,965	7,381	7,381	3,876	-3,505
Subtotal	7,965	7,381	7,381	3,876	-3,505
Tar sands:					
Operating expenses	1,180	1,317	1,317	...	-1,317
Subtotal	1,180	1,317	1,317	...	-1,317
Total					
Operating expenses	11,702	11,454	11,454	4,484	-6,970
Enhanced oil recovery	$11,702	$11,454	$11,454	$ 4,484	$ -6,970
Staffing Total FTE's: Direct ...	6	6	6	3	-3
Indirect .	17	17	17	10	-7

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Conference	General Reduction	G-R-H Reduction	Total
Enhanced oil recovery (FE)				
Heavy Oil:				
Operating expenses.....	$ 2,886	$-17	$-113	$2,756
Light Oil:				
Operating expenses.....	7,721	-38	-302	7,381
Tar sands:				
Operating expenses.....	1,379	- 8	- 54	1,317
Subtotal, Enhanced Oil Recovery (FE).....	11,986	-63	-469	11,454
General Reduction:				
Operating Expenses.....	-63	63	-	-
Total, Enhanced Oil Recovery (FE)	$11,923	-	$-469	$11,454
Operating Expenses.....	11,923	-	-469	11,454

Summary of Changes

FY 1986 Appropriation enacted	$11,454
Program increases and decreases:	
Heavy Oil	
o Complete national laboratory and university studies on basic oil mobilization and EOR process mechanisms and focus research at NIPER	-2,148
Light Oil	
o Complete university research studies on chemical flooding and focus efforts at NIPER	-3,505
Tar Sands	
o Discontinue laboratory/bench scale efforts to investigate thermal recovery kinetics and mechanisms and to identify promising recovery concepts.	-1,317
FY 1987 budget request	$ 4,484

Enhanced oil recovery:

Goals/Objectives:

The goal of the Enhanced Oil Recovery (EOR) program is to conduct generic technology base R&D activities; develop fundamental knowledge that can lead to improved and new process concepts; and to assist industry in obtaining a better understanding of the mechanisms and behavior of advanced and novel EOR processes for the recovery of presently unrecoverable light oil, heavy oil and tar sand resources.

Enhanced Oil Recovery (EOR), often used synonomously with Tertiary Oil Recovery is the term used for recovery techniques applied after conventional means are employed or where conventional means are not effective. Conventional methods include primary recovery where natural, in situ drive mechanisms are utilized to produce the oil, or secondary water flood techniques are used to displace additional oil. Enhanced recovery or tertiary oil recovery methods usually represent the third attempt to recover the otherwise unrecoverable oil, except for heavy oil and tar sand reservoirs where EOR technologies may have to be applied from the very beginning.

One of the most comprehensive reports on the future of EOR in the United States was recently completed by the National Petroleum Council (NPC) at the request of the Secretary. The study points out that only 27% of all the oil discovered in the United States was produced (130 billion barrels) and that only 6% remains to be produced with conventional technologies (28 billion barrels). This leaves 323 billion barrels or 67% of the otherwise unrecoverable oil as the target for EOR. This oil remains out there, not waiting to be discovered but in places we know, in fields that are opened, but trapped in geology and by forces that are still beyond the grasp of today's production technology.

The NPC study recommends a number of research areas in EOR and states in the transmittal letter to the Secretary that "only through continued process research and field testing with both industry and government support, can the large volume of hydrocarbons discussed in the report be produced." Using today's EOR knowhow, the NPC report concludes that 14.5 billion barrels--the equivalent of about half our current recoverable reserves--could be added to the domestic crude oil supply. Further, NPC concludes that advances in technology could double that amount. This still leaves more than 300 billion barrels of oil in the ground.

Because of the present world energy situation and restructuring of the oil industry, exploration for new reserves has dropped off, particularly in the domestic arena. But

even in the recent past when exploration was at a peak, reserves were being added at a rate far below that previously experienced, and the average size of reservoirs discovered was found to be declining rapidly. Overall, domestic production has been on the decline for 15 years with some states experiencing serious economic consequences, because of drastic reductions in production. This only emphasizes the importance of relying on existing, but currently unrecoverable, oil resources and new technologies to recover that oil. Also, from a purely strategic point of view, EOR can help fill the oil supply shortfall after the strategic reserve runs out and before synthetic fuels make measurable impact on oil supply.

Fundamental research envisioned under the EOR program expects to look at the problem as a whole and will attempt to provide solutions to discrete research requirements which can then become the necessary building blocks for innovative process development by the industry. The focus of the EOR program is thus based on obtaining a clearer understanding of the scientific processes through long-range technology base research.

The U.S. does have considerable heavy oil (approximately 100 billion barrels) and tar sand resources (54 billion barrels) but our neighbors to the north and south have orders of magnitude larger in-place resources. Canada has an estimated 1.2 trillion barrels contained in their tar sands and Venezuela has 1 to 4 trillion barrels in their heavy oil deposits. Mexico is still determining the magnitude of their petroleum deposits (both heavy and light oil) but they are known to be vast. It is therefore important from a strategic standpoint to develop efficient, effective and economic recovery technologies for these resources. The fact that Canada, Venezuela and Mexico have mutual interests in recovery research affords us the opportunity to leverage our resources through cooperative research efforts. We do in fact have active and mutually beneficial agreements in place with these countries and are task sharing research on defined critical needs.

The specific objectives of the EOR program are to:

- o Conduct fundamental research into the behavior of light oil EOR processes such as micellar-polymer and carbon dioxide flooding with mobility control for significantly higher recovery efficiency.
- o Develop a better understanding of heavy oil EOR processes such as steam flooding, and the complex chemical/physical in situ mechanisms by which oil is mobilized and recovered efficiently.
- o Evaluate and develop new concepts for in situ recovery of bitumen from U.S. tar sands deposits.
- o Provide technical support and conduct environmental research pertaining to hazards in use of chemicals in light oil recovery and to combustion products from thermal recovery of heavy oils.
- o Continue technology transfer activities with government agencies and industry.
- o Evaluate environmental impediments or concerns which could constrain realization of EOR goals.

FY 1986 Accomplishments:

- o Continued joint research with Venezuela and Mexico on heavy oil characterization, thermal recovery evaluation, subsidence prediction and reservoir modeling.
- o Phased out university investigations into the kinetics of oxygen-enriched in situ combustion and National Laboratory research into the generation and stability of foam in reservoirs.
- o Continued fundamental studies of surfactant behavior in EOR concepts and applications.
- o Continued studies of geologic heterogeneities and other characteristics on EOR process shortcomings.
- o Conducted basic studies of rock-fluid interaction phenomena and behavior.
- o Continued studies of CO_2 displacement mechanisms and viscous channeling and mobility control concepts.

- Continued joint test program with Canada for assessing advanced concepts of remote tracking of thermal fronts for control of in situ combustion process of tar sands recovery, and cooperative development of methodology for tar sand resource and bitumen analysis.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Heavy oil	$ 2,756	$ 608	$ -2,148

FY 1987 funding for this subprogram is $608,000, a reduction of $2,148,000 from the FY 1986 funding level. This reduction will result in the following:

- Completion of research on in situ combustion reaction kinetics and variables in alkaline flooding in EOR.
- Completion of the remaining joint research with Venezuela and Mexico on novel heavy oil recovery processes.

Heavy oil (10^{o}-20^{o} API gravity) makes up an estimated one-third of the U.S. petroleum resource, or about 100 billion barrels. This heavy oil is very viscous, somewhat like molasses, and hence moves very slowly in the reservoir. For this reason, very little heavy oil is produced during primary recovery, and enhanced recovery techniques are required for further production. The most common EOR methods are targeted towards the reduction of viscosity of the heavy oil in place so that it can flow easily through the reservoir. Current technologies consist of applying heat to the reservoir through injection of steam or by in-situ combustion.

About 450,000 barrels of heavy oil is produced daily (mostly in California) using thermal recovery methods. Despite this apparent success, experts agree that the potential for heavy oil recovery is much larger (NPC Study on EOR, 1984). The main problem in thermal recovery is that of efficient displacement of the oil. Because of its light weight and very low viscosity, steam tends to bypass a large portion of the reservoir and breaks through to the producing wells. Research is required on modifying the flow behavior of steam which can result in greatly improved displacement efficiency. Materials are needed which can withstand the high temperature, pressure, and the dynamics of flow through the reservoir rocks. Certain chemical additives are proving to be useful in yet to be fully understood ways in improving steam displacement efficiency in selected reservoirs. In-situ combustion processes are more complex and still require a great deal of basic research to obtain a complete understanding of its subsurface behavior.

Certain heavy oils have acidic components that can react with alkaline chemicals to form surfactants in place. Alkaline chemicals such as sodium hydroxide can thus be used to initiate an in-situ surfactant flood. Further understanding of the reactions is necessary before this method can be applied with reasonable predictability.

The EOR heavy oil research program is mainly focused towards significantly improving the displacement efficiency of thermal recovery processes. To achieve this, research in modification of steam flow behavior, mobility control, chemical additives and kinetics of in-situ combustion will be required. Basic research efforts in use of alkaline chemicals for surfactant flooding will also be needed. As in the case of light oils, methods beyond those presently conceived will be required to recover much of the heavy oil. Thus an essential element of the Heavy Oil subprogram will be to explore new concepts for producing this remaining oil.

To address the vast amount of residual oil remaining even after applying the presently conceived advanced case technologies requires new approaches. Microbial EOR (MEOR) is one such approach, i.e., the use of micro-organisms to lower viscosity, develop miscible gases, etc., for displacement of the residual oil. Preliminary concept feasibility analyses have been done under the APT program. The potential has been established and

the effort transferred to the EOR program to begin the research toward developing MEOR systems concepts. Also, to address the more challenging complex reservoir conditions associated with the bulk of the oil remaining, alternate strategies to affect more control over the reservoir will be required than are possible with presently conceived systems.

As mentioned previously, the worldwide resources of heavy oil are enormous, especially in neighboring countries such as Canada, Mexico and Venezuela. Active and mutually beneficial cooperative research conducted in FY 1986 and previous years will be continued in FY 1987 with these countries in critical areas if such research competes successfully for funds under the Oil, Gas and Shale Cooperative R&D Venture Pool.

In FY 1986, heavy oil research included theoretical studies of multiphase fluid flow using steam with foam for mobility control, physical and computer simulation of steam with additives, kinetics of oxygen-enriched in-situ combustion, and continuation of research with Venezuela and Mexico.

In FY 1987, heavy oil research will be focused at the National Institute for Petroleum and Energy Research (NIPER). Taking advantage of the government/industry interface afforded through this institution, work will include the following:

- o Identification of additives for improving thermal recovery methods and investigation of the mechanisms to enable design of improved techniques.
- o Use of physical models and mathematical simulation to evaluate steam flooding and in-situ combustion in terms of kinetics, rheology, and displacement process.

	FY 1986 Approp.	FY 1987 Request	Net Change
Light oil	$ 7,381	$ 3,876	$ -3,505

FY 1987 funding for this subprogram is $3,876,000, a reduction of $3,505,000 from the FY 1986 funding level. The effect of this reduction will be the phasing out of basic research and pursuit of novel extraction concepts studies performed at several universities and National Laboratories.

Light oil (over 20^{o} API) constitutes the largest percentage of the domestic crude oil resource--with approximately 230 billion barrels remaining in the ground as a target for EOR. There exist two core technologies for the enhanced production from light oil reservoirs: chemical flooding and miscible gas flooding.

Chemical flooding techniques involve the injection of surfactants in the target formation to reduce surface tension and ionic bonding between the residual oil and connate water and residual oil and sedimentary rock surfaces. A polymer slug is injected behind the surfactant to drive the fluid through the formation. In the laboratory, high recovery efficiencies are realized. However, in the field the results have for the most part been disappointing and unpredictable. The mechanisms that appear to cause the erratic and inefficient performance in the field relate to chemical and physical breakdown of the surfactant and polymers under formation pressures, temperature, high salinity and complex checmical composition; to adsorption and absorption of the surfactants; and to non-uniform flow behavior. Development of predictable, efficient and economical chemical flooding EOR technologies require a thorough understanding of the rock/fluid interactions and identification of surfactants and polymers compatible with the range of reservoir conditions encountered. Industry and DOE, under the EOR program, have conducted research in the past to address the problems associated with this technology. Recent and continuing DOE efforts will be focusing on the long-term, more fundamental research to build an analytical base as recommended by the NPC study.

Miscible gas (CO_2) recovery involves the injection of CO_2 into the formation under pressure. The CO_2 dissolves into the residual oil in the reservoir and works as a solvent to reduce viscosity and enhance flow characteristics. It is quite effective where it makes contact with the residual oil. Unfortunately, CO_2 moves rapidly through the formation because of its low viscosity relative to the formation fluids. The result is low sweep efficiency with the gas following the path of least resistance. Research by industry and DOE has therefore focused on developing mobility control methods, e.g., the addition of chemicals (such as foaming agents) to increase viscosity and enhance sweep efficiency. As in the case of chemical flooding, the DOE work is fundamental to provide an analytical base for industry efforts.

In FY 1986, light oil research activities included fundamental studies of surfactant properties and geologic parameters as they affect chemical flooding, continuation of research in phase behavior and viscous fingering phenomena in miscible gas flooding and comprehensive post-project analysis and updating and documenting of six process models.

The FY 1987 budget will allow continuation of NIPER's fundamental research into the recovery mechanisms and physical and chemical phenomena which hold the residual oil in the reservoir and prevent displacement. Work will include: investigations of polymer rheology and stability at elevated temperatures; effects of pore size on injectivity; absorption behavior of surfactants; the relationship between electrical properties and stability of colloidal surfactant systems; and the fundamental chemistry of copartitioning alcohol/surfactant systems. NIPER will also continue its studies of nitrogen and CO_2 gas flooding concepts, both miscible and immiscible, with emphasis on displacement mechanisms, mobility control, and the development of improved screening criteria. Microbial EOR, previously part of the APT program will now be a part of the EOR program and be addressed under the NIPER cooperative agreement. Similarly, METC will continue laboratory core testing of CO_2-surfactant-water foam systems of mobility control and basic CO_2 process technique assessments using its innovative miscible black oil model. Post-test analysis and process evaluation will be completed for the recently completed, cost-shared field test of micellar polymer EOR.

	FY 1986 Approp.	FY 1987 Request	Net Change
Tar sands	$ 1,317	$ ...	$ -1,317

No funds were requested in FY 1987 for this subprogram. All activities, except previously funded, task shared, U.S./Canadian basic tar sand research activities, will be completed in FY 1986.

Tar sand bitumen (less than 10° API) is a semi-solid, bituminous substance similar to asphalt or resin. It is totally immobile in the reservoir and therefore must either be mined and processed at the surface as in Canada, or heated in situ as in heavy oil recovery. Domestic tar sand resources are estimated at 54 billion barrels, however, currently there is no commercial production from these deposits.

Canada, however, produces over 200,000 BPD of bitumen and has an ongoing research program in tar sands. Although its commercial operations are largely surface processing, research emphasis is swinging toward in situ recovery in preparation for the day when its easily mined deposits run out. The surface processes developed in Canada serve as a starting point for design of technologies compatible with the estimated 15-20% of our tar sands amenable to mining and surface processing.

In FY 1986, DOE tar sand research focused on the development of concepts of recovery principally at the Western Research Institute (WRI) under an initial cooperative agreement expiring at the close of FY 1986, using small scale tube reactors and unique block test apparatus (allowing tests on 2x2x6 foot consolidated tar sand samples) to investigate in situ thermal recovery scenarios and the effect on product yield and quality and waste stream pollutant species and concentrations. A limited effort

conducted at the University of Utah to explore surface process technologies compatible with major U.S. tar sand deposits and to examine techniques for efficient separation of bitumen from the process fluids was similarly phased out. In addition, through the Office of the Canadian Federal Government and the Provinces of Alberta and Saskatchewan, Canada has continued to extend and fund cooperative research endeavors with DOE in tar sand research in the development of steam with additives technology and in situ mechanisms to enhance sweep efficiency; and in development and field testing of a cost effective remote thermal front tracking capability.

In FY 1987, basic tar sand research activities will be limited to previously funded, task shared, U.S./Canadian activities. These research activities could be supplemented by funds under the oil, gas and shale cooperative R&D venture pool.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
PETROLEUM
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Oil shale (FE)					
Oil shale technology base:					
Operating expenses	$ 8,728	$ 8,447	$ 8,447	$ 3,078	$ -5,369
Subtotal	8,728	8,447	8,447	3,078	-5,369
Environmental mitigation:					
Operating expenses	5,900	3,689	3,689	517	-3,172
Subtotal	5,900	3,689	3,689	517	-3,172
Total					
Operating expenses	14,628	12,136	12,136	3,595	-8,541
Oil shale	$14,628	$12,136	$12,136	$ 3,595	$ -8,541
Staffing Total FTE's: Direct ...	10	13	13	12	-1
Indirect .	7	8	8	8	0

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Conference	General Reduction	G-R-H Reduction	Total
Oil Shale (FE)				
Oil shale technology base:				
Operating expenses.....	$ 8,839	$-47	$-345	$8,447
Environmental Mitigation				
Operating expenses.....	3,860	-20	-151	3,689
Subtotal, Oil Shale (FE)	12,699	-67	-496	12,136
General Reduction:				
Operating Expenses	-67	67	-	
Total, Oil Shale (FE)	$12,632	-	$-496	$12,136
Operating Expenses.....	12,632	-	-496	12,136

Summary of Changes

FY 1986 Appropriation enacted	$12,136
Program increases and decreases:	
Oil Shale Technology Base	
o Reduced specific eastern oil shale research	-472
o Discontinue further development of ASPEN codes specific to oil shale systems analysis	-122
o Reduce laboratory studies of reference shale retorting and modeling for solids recycle systems	-991
o Discontinue in situ process and fragmentation model development	-2,834
o Defer further activity in oil shale extraction research	-956
o Continue development of the data base	+6
Subtotal	-5,369
Environmental Mitigation	
o Discontinue studies to develop siting methodology	-376
o Reduce environmental data base activities	-94
o Discontinue research on nitrogen emissions and sulfur capture in solids-recycle retort systems	-192
o Reduce real-time emissions measurements consistent with reduced reference shale retorting studies in moving beds and in in situ simulating laboratory retorts, and defer further studies of critical questions associated with spent shale disposal	-2,510
Subtotal	-3,172
FY 1987 budget request	$ 3,595

Oil shale:

Goals/Objectives:

The goal of the Oil Shale R&D program is to provide a sound technologic basis for reduction of economic and environmental constraints to industrial development of the U.S. oil shale resources; and to increase the amount of resource that may be used economically.

Oil Shale represents a vast hydrocarbon resource in the U.S. that can be converted to a broad spectrum of products from raw kerogen (the heavy complex hydrocarbon contained in the mineral matrix) which can be combusted or used as a petrochemical feedstock, or converted to diesel and jet fuel. An estimated 1.8 trillion barrels of oil equivalent reside in place in the Green River Formation of Colorado, Utah and Wyoming; and an equal volume is believed to exist in the more far ranging (and less explored) Devonian and Mississippian oil shales of the east and midwest. The Western, Green River Formation deposits, are in fact marlstones formed from fresh water lakes. They have a high carbonate composition, and high hydrogen to carbon ratio in the organics creating chain structures called aliphatics. The Eastern, Devonian and Mississippian deposits are true marine shales. They have a high Illite content, and relatively low hydrogen to carbon ratio in the organics creating ring structures called aromatics. Alphatics are more easily converted to liquids with heat than are aromatics; therefore, eastern shales with the same organic content as a western shale will produce less liquid when subjected to a simple heating process. However, a drawback to retorting of Western shales is the carbonate which absorbs heat upon decomposition.

A suite of oil shale surface retort technologies exist today for processing high volumes of Western shale at what can best be described as marginal economics (45-55 $/BBL). In

situ retort technologies have been proven for certain site specific situations, e.g., the Geokinetics process where shallow lying thin deposits on the basin rims can be sufficiently fragmented to affect reasonable recovery. Modified in situ technology such as that proposed by Occidental poses economic questions and a high degree of risk because of the fairly extensive mining associated with it and an inability to predict, from one geologic setting to another, whether an explosive design will provide the necessary fracturing. Also, there are environmental questions associated with eventual abandonment. There is a need to explore more efficient, economic recovery systems and systems that can be applied effectively to a larger percentage of the resource. Excluding the Occidental Vertical Modified Insitu approach, the remainder of the approaches are at best marginally economic when applied to the easily accessed high grade zones representing only 5 to 10% of the total Western resources.

Aside from the conversion process, there are significant cost and environmental considerations relative to air, water and solid wastes generated from oil shale plants. As to the air emissions, best available control technology can be applied to meet standards for regulated pollutants for a single plant. But required environmental considerations would soon limit industry development due to total allowed emissions. Clean-up of process water and codisposal with spent oil shale pose significant potential impact to the regions hydrology and ecology. Evaporative emissions from the spent shale, spent shale pile structural and chemical stability, and transport of toxic substances to vegetation must be evaluated and mitigation methods developed before an oil shale industry will achieve environmental acceptability.

The Oil Shale Program was restructured in FY 1984. Evolving from that restructuring was a systems approach to develop essential process and environmental data for both Eastern and Western shales. Eastern and Western shales are to be selected on the basis of established criteria, subjected to an indepth characterization of organic and inorganic constituents. These reference shales are then to be processed in laboratory retorts under a prescribed set of conditions and the product and waste streams are to be characterized to determine the fate of the oil shale constituents as a function of process condition. Other aspects of the restructured program are to focus on environmental problems discussed above; and to explore promising new concepts for enhanced process economics, recovery efficiency, and reduced environmental impact.

As a result of new administration policy, the Oil Shale program will focus on the basic research using reference shales to systematically study the chemistry, kinetics, and emissions related to eastern and western oil shale processing. High capacity, continuous throughput solids recycle process conditions will be emphasized for the near term. Present contracts with industry to explore new concepts will be completed or terminated in FY 1986. In FY 1987, such oil shale projects could be eligible to compete for Fossil Energy joint venture pool funds.

FY 1986 Accomplishments:

FY 1986 accomplishments include:

- Completion of reports by Western Research Institute on incorporation of gas pressure drop, individual oil boiling fractions and liquid water behavior into the one-dimensional retorting model; on radiofrequency heating tests to measure oil yields at different heating rates; and on ambient emissions of spent shales.
- Completion of a final report on preliminary design of a 500 Tpd pilot plant utilizing a roller grate retort and Indiana shale.
- Completion by Los Alamos National Laboratory of reports on oil shale fragmentation tests conducted at the Anvil Points and Colony mines; and on a study to develop prioritized issues relative to commercial facility siting.
- Completion of report of phase I and II of a project to determine the feasibility of in situ retorting of Indiana oil shale.
- Completion of report by Lawrence Livermore National Laboratory of studies of reduction of NO_x emissions, and on operation of a solids recycle system with fluidized bed pyrolyzer and gravity flow mixer.

- o Completion of a report by the University of Alabama Mineral Resources Institute on assessment of U.S. oil shales amenable to beneficiation followed by hydroretorting. Three of the most promising shales are to be selected for further testing.
- o A report on the first year effort to expand the technology base for moving-bed hydroretorting of eastern shales including fines utilization is expected to be prepared by Hycrude, Inc.
- o Initiate and complete studies to determine research needs and recommended tasks/activities for implementation of an oil shale extraction research program through the Idaho Operations Office.
- o Initiate a cooperative agreement with the Western Research Institute (WRI).

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Oil shale technology base	$ 8,447	$ 3,078	$ -5,369

The FY 1987 funding request for this subprogram is $3,078,000, a reduction of $5,369,000 from the FY 1986 funding level. This requires consolidation of the previous LLNL work on solids recycle chemistry and modeling into METC's research as subsequently described, and termination of all work at LLNL, SNL, and LANL.

The goal of the Oil Shale Technology Base program is to conduct basic research that provides a sound scientific basis for reduction of economic constraints to industrial development of the U.S. oil shale resources and to increase the amount of resource that may be used economically.

In FY 1986, efforts conducted at WRI emphasized basic research to improve understanding of the criteria for successful in situ processing of oil shale; detailed characterization studies of reference eastern and western shales; and basic research on new process concepts. Other WRI activities are described under Environmental Mitigation. Also in FY 1986, a contract study of a roller grate process concept applied to Indiana shale was completed, and a contract study of an in situ process concept applied to Indiana shale was continued and scheduled for completion in FY 1987. A university contract study of eastern shale beneficiation and hydrogen retorting was continued in FY 1986 and will be phased out in FY 1987 utilizing prior year funding. A contract study involving further applied research on eastern shale hydrogen retorting will be completed in FY 1987. Studies will be implemented and completed in FY 1986 to identify research needs in oil shale extraction and to propose a program for implementation through DOE's Idaho Operations Office as directed by the Congress.

In FY 1986, basic research was ongoing at Lawrence Livermore National Laboratory (LLNL) on solids recycle retorting and modeling; at Sandia National Laboratory (SNL) and Los Alamos National Laboratory (LANL) on in situ process and fragmentation modeling; and at Morgantown Energy Technology Center (METC) on process chemistry and kinetics, systems analysis, and development of computerized data bases.

In FY 1986, a contract awarded to Terra Tek, Inc., in FY 1985 to obtain reference shales and maintain a sample bank in support of the in house research program was continued, and will be continuing in FY 1987.

In FY 1987, the Morgantown Energy Technology Center will carry out an in-house program of research in the following areas:

- o In depth characterization of oil shales to undergo process studies to provide a reference from which to interpret process mechanisms; and characterization of process products.
- o Rapid pyrolysis studies on both eastern and western shales to define kinetics and mechanisms of oil shale decomposition phenomena and how process conditions affect product yield and quality.

- o Modeling of process phenomena to provide a framework to deal with process variables; to build an understanding of the interrelationship between process parameters; and to serve as a tool in designing experiments to fill data gaps.
- o Experimentation to address liquid-phase organic formation from organic vapors.
- o Quantification of the breakdown experienced by spent shale in solids recycle retort systems and the effect on heat transfer capability.
- o Development of a generic solids recycle process model incorporating retort and combustor phases.

	FY 1986 Approp.	FY 1987 Request	Net Change
Environmental mitigation	$ 3,689	$ 517	$ -3,172

The goal of the Oil Shale Environmental Mitigation program is to conduct basic research that provides a sound scientific basis for reduction of environmental constraints to industrial development of U.S. oil shale resources and to increase the amount of resource that may be used economically.

The FY 1987 funding request for this subprogram is $517,000, a decrease of $3,172,000. This reduction is a result of completing siting methodology studies as well as research on nitrogen emissions and the capture of sulfur by oil shale compounds under varying process conditions. The largest reduction however, is associated with efforts identifying and quantifying major and trace element emissions in gases, liquids and solids from reference shales.

In FY 1986, WRI completed basic research on solid waste and co-disposal and characterization of air and water emissions. Sulfur and nitrogen chemistry work that was being performed at Lawrence Livermore Laboratory during FY 1986 will be integrated with ongoing research at the Morgantown Energy Technology Center (METC). Los Alamos National Laboratory completed a study in FY 1986 of research needs pertinent to developing a methodology for analyzing impacts of oil shale facility siting. No further work in siting methodology will be conducted in FY 1987.

In FY 1987, METC will carry out an in-house program of research in the following areas:

- o Developing a fundamental understanding of the role of solids in solids recycle retorts in regard to removal of sulfur and nitrogen from vapor phase organic compounds during oil shale retorting.
- o Determining the extent of solids carryover into the product stream from solids recycle retorts and exploring mitigation strategies.
- o Modeling the sulfur and ammonia recovery process sections of a generic oil shale plant to aid in quantifying the impact of applying various retort process options.
- o Applying systems analysis methodologies to help define and prioritize research needs.

In FY 1987, under a annex to an umbrella agreement with Israel, research concerned with sulfur compound identification in oil shale waste streams is expected to continue as is health and safety related research support under an Interagency Agreement with the Bureau of Mines.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
GAS
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Unconventional gas recovery (FE)					
Eastern gas shales:					
Operating expenses	$ 2,852	$ 938	$ 938	$ 355	$ -583
Subtotal	2,852	938	938	355	-583
Western tight gas sands:					
Operating expenses	5,028	5,393	5,393	3,582	-1,811
Subtotal	5,028	5,393	5,393	3,582	-1,811
Environmental and advanced research:					
Operating expenses	2,262	2,172	2,172	1,315	-857
Subtotal	2,262	2,172	2,172	1,315	-857
Total					
Operating expenses	10,142	8,503	8,503	5,252	-3,251
Unconventional gas recovery	$10,142	$ 8,503	$ 8,503	$ 5,252	$ -3,251
Staffing Total FTE's: Direct ...	10	11	11	10	-1
Indirect .	12	11	11	10	-1

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Conference	General Reduction	G-R-H Reduction	Total
Unconventional gas recovery (FE)				
Eastern gas shales:				
Operating expenses	$ 981	$- 5	$- 39	$ 938
Western tight gas sands:				
Operating expenses	5,642	29	-220	5,393
Environmental and advanced research				
Operating expenses	2,273	-12	- 89	2,172
Subtotal, Unconventional Gas Recovery (FE)	$8,896	$-46	$-347	$8,503
General Reduction:				
Operating Expenses	-46	46	-	-
Total, Unconventional Gas Recovery (FE)	$8,850	-	$-347	$8,503
Operating Expenses	8,850	-	-347	8,503

Summary of Changes

FY 1986 Appropriation enacted	$ 8,503
Program increases and decreases:	
Eastern Gas Shales	
o Cancel scheduled stimulation of horizontal well drilled in FY 1986; also termination of planned stimulation model validation efforts	-583
Western Tight Gas Sands	
o Reduce level of effort in Multiwell Experiment and supporting research	-1,016
o Discontinue geologic/engineering studies of the Uinta and Greater Green River Basins	-253
o Discontinue supporting research for the Western Gas Sands program	-542
Subtotal	-1,811
Environmental and Advanced Research	
o Discontinue all university laboratory/field property determiniation efforts for gas hydrates and terminate all contract geologic characterization efforts	-612
o Discontinue detection/differentiation system development for deep source gas	-245
Subtotal	-857
FY 1987 budget request	$ 5,252

Unconventional gas recovery:

Goals/Objectives:

The unconventional gas resource in place is large, on the order of thousands of trillion cubic feet (TCF) and many times the size of our domestic reserves. The primary issue surrounding unconventional gas is not its size, but how much of the resource can be recovered. However, recovery of these resources represents a technological challenge. If successfully met, this additional gas combined with conventionally recovered gas would represent a secure domestic supply that could meet the nation's needs well into the next century both for existing markets and in an expanded market displacing imported oil.

The unconventional gas resources addressed under the UGR program are the tight lenticular sand formations of the west, fractured shales of the east, and the lesser known novel gas resources of gas hydrates and deep sources. Each of these resources is large, or estimated to be large, but is lacking a sufficient knowledge base to warrant significant industry investment. They are all geologically complex and require advances in extraction technology if substantial volumes are to become technically and economically producible.

The specific objectives of the Unconventional Gas Recovery program are to:

- o Reduce the uncertainty surrounding the potential magnitude of reserves of the unconventional gas resources and the conditions under which they will be produced.
- o Develop and improve extraction technologies to the point of technical readiness for private sector development.
- o Transfer all technical and economic data to industry.

FY 1986 Accomplishments:

Eastern Gas Shales
- o Completed installation of a directionally drilled horizontal well to test for increased gas recovery efficiency.
- o Established hydraulic fracturing design criteria for natural fractured reservoirs using physical-scaled models.
- o Completed testing and analyses from a second offset well test facility.

Western Tight Gas Sands
- o Completed geologic analyses and assessment for the Greater Green River Basin in Wyoming.
- o Continued efforts in validation of fracture conductivity models for proppant transport.
- o Completed tests of the high energy gas frac process through perforated casing.
- o Completed coastal sandstone interval stimulation at the multiwell experiment site.

Environmental and Advanced Research
- o Completed preliminary mapping of gas hydrate deposits on the Alaskan North Slope.
- o Continued site specific geologic evaluations of probable offshore hydrate deposits.
- o Established resource potential for deep source gas in target areas along the U.S. west coast.
- o Completed field examination of potential deep source gas occurrences at priority sites in western Washington.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Eastern gas shales	$ 938	$ 355	$ -583

The reduction in funding from FY 1986 to FY 1987 reflects the elimination of those research activities performed under industrial contracts. The projects supported in FY 1987 are focused on in-house research.

The fractured Devonian shale formations of the east and midwest represent an in-place resource in excess of 900 TCF. This information was developed in the early years of the programs, when research efforts were directed at determining the geologic character and magnitude of the shale gas resource. Research efforts progressed to detailed reservoir analysis such as the Offset Well Test No. 1 (drilled in an area of established commercial gas production). The Offset Well Test involves the drilling of closely spaced wells to interrogate the reservoir under baseline conditions. From this work evolved a reservoir model quantifying the interrelationship of identified key reservoir parameters. To validate the reservoir model, a contract was awarded in FY 1984 to obtain additional defined information from selected areas (10 wells) and to establish a second Offset Well Test site in an area with no commercial production history but meeting certain geologic criteria determined by the reservoir model. Testing and evaluation at the second Offset Well site should be completed by early in FY 1987 with prior year funding.

Effective stimulation or the ability to predict that a stimulation technique will provide the needed performance remains as the key research need in the program. One concept, developed from recent reservoir studies, is that of a stimulated horizontal borehole. The same studies indicate that we can expect a multi-fold increase in gas recovery over conventionally stimulated vertical wells where typically only 10-25% of the gas in-place is recovered. The concept takes advantage of the natural fracture pattern by directionally drilling a horizontal wellbore perpendicular to the fracture planes, extending several hundreds of feet, and subsequently stimulating the reservoir at selected intervals. Drilling of the directional well will be completed during FY 1986. During drilling, core will be taken to obtain valuable data for reservoir and stimulation models. The state-of-the-technology for directionally drilling the desired

wellbores will be ascertained. Gas flow data from the directionally drilled well can be compared directly with that from adjacent, vertically drilled and completed wells. Stimulation of the well was scheduled to take place in FY 1987 under the technology base program. An attempt will be made in FY 1987 under the Cooperative R&D Venture Pool to solicit industry support in conducting the stimulation and analysis of this promising recovery concept. Planned field testing/evaluation of stimulation models which were to have been carried out in a variety of geologic settings at different fracture intensities will be cancelled.

DOE's in-house research efforts will continue in FY 1987 to focus on the development of predictive capability, i.e., stimulation and reservoir modeling, and on the integration of previously derived laboratory and field data to establish guidelines for industry on ways to optimize gas development/production from shale and associated reservoirs. The technical approach, which utilizes case history studies, will be applied systematically to previously ranked areas of shale production potential to investigate the following: the practical aspects of dual completion from shale and associated sandstone and coal reservoirs; and prospects for in-fill drilling in areas of different natural fracture intensity. Successful completion of these efforts should greatly enhance the economics of Devonian shale gas development. In addition, in-house efforts will continue in the gathering of available production data from shale wells. The data will be compiled and loaded onto a production data base system for subsequent use by modelers and industry.

In-house research activities for the Eastern Gas Shales subprogram are assigned to the Morgantown Energy Technology Center.

	FY 1986 Approp.	FY 1987 Request	Net Change
Western tight gas sands	$ 5,393	$ 3,582	$ -1,811

The reduction in funding from FY 1986 to FY 1987 reflects the elimination of those research activities performed under interagency agreements, national laboratories, and universities. The projects supported in FY 1987 are focused on in-house research and continuation of multiwell research activities.

Supporting research in the area of proppants and fluids for effective western gas sands stimulation and laboratory investigations into fracture propogation/communication across and between sand lenses will be terminated. Parallel efforts to provide the geologic backdrop to understand reservoir properties and response to stimuli, for the major basins will also be terminated.

The U.S. has a very large resource of gas held in low permeability sandstone formations. An NPC study estimated the in-place resource for these tight formations at 924 TCF. Of this resource, up to 300 TCF are contained in tight and mostly lenticular gas sands of the Rocky Mountain geologic basins. DOE's program focuses on these tight lenticular formations. Early in the subprogram history, a series of individual massive hydraulic fracturing (MHF) field experiments were performed. The results were very erratic and difficult if not impossible to explain. This led to the concept of the Multi-well Experiment (MWX) which consists of three closely spaced wells (125-150 ft apart) drilled to a depth of 7,500 feet and penetrating many lenticular sandstones. The experiment is designed to investigate the production characteristics of tight lenticular sandstones and to develop the strategies to effectively extract the resource, as well as to develop reservoir and stimulation diagnostics and predictive capability. The program strategy is to study and resolve technical problems at the MWX site, and then extrapolate these results across the Piceance Creek Basin and finally to the other two priority basins (Greater Green River and Uinta). Installation of the MWX facility was completed in FY 1983. A five-year experimental plan was developed to systematically obtain needed information. It is scheduled to end in FY 1988 with expiration of the current lease. During FY 1986, the last in a series of stimulations in the Coastal zone will be completed.

During FY 1987, field experiments will concentrate on the feasibility of stimulating and producing gas from remote sand lenses (not directly intersected by the wellbore). Stimulating and producing from remote sand lenses is the key to economic and efficienct recovery of gas from tight lenticular gas sands.

In FY 1987, in-house research activities will continue. Emphasis will be on the analysis of reservoir, stimulation, and geologic data derived from the multiwell experiment. In-house geoscience studies will contribute knowledge to a better understanding of the various processes affecting gas recovery from lenticular sands. These efforts include log versus core studies (permeability), fluid/rock interactions during stimulation and lineament analysis. Together with selective data from industry test wells in other parts of the Piceance Basin, when available, researchers will attempt to extrapolate MWX results to other areas. Database activities will also continue with the gathering and loading of individual well production data as available from the Piceance and Greater Green River Basins.

In-house research activities for the Western Tight Gas subprogram are assigned to the Morgantown Energy Technology Center.

	FY 1986 Approp.	FY 1987 Request	Net Change
Environmental and advanced research	$ 2,172	$ 1,315	$ -857

The reduction in funding from FY 1986 to FY 1987 reflects the elimination of those research activities performed under industrial contracts, and universities. The projects supported in FY 1987 are focused on in-house research and geophysical/ geochemical efforts under interagency agreements.

Workshops were held during FY 1982 for both gas hydrates and deep source gas. The primary purpose of these workshops was to thoroughly review past and ongoing research in these potential resource areas and to serve as a basis for formulating a program of research. From these workshops it became clear that little was known about either gas resource and that little research was being carried out in these areas. It was determined that a systematic and coordinated project was warranted to substantiate the presence, define the reservoir characteristics and develop recovery strategies for both the gas hydrates and deep source gas (specifically the deep source gas associated with subduction of organic materials at tectonic plate margins).

Under certain temperature and pressure regimes, gas in the presence of sufficient moisture will form gas hydrates - gas trapped in an ice crystal matrix (such structures are called clathrates). In addition, gas is also thought, in many situations, to be trapped beneath the main hydrate layer, forming a "free gas" zone. It is theorized that gas hydrates and associated free gas may represent a vast resource in excess of 2,500 TCF. However, little information exists to prove or disprove the theory.

In a coordinated effort with NSF, DOE, in FY 1983, began evaluating natural hydrate core taken during deep drilling operations off the coast of Guatemala. The laboratory program (aided eventually by the use of synthetic gas hydrates) set out to obtain basic chemical, physical, and thermodynamic properties and tc evaluate diagnostic techniques that might be used to identify and quantify gas hydrates in situ. A parallel effort was undertaken to create a gas hydrate reservoir model, and using the model, to investigate recovery scenarios (both thermal and depressurization techniques are being examined). Both of these efforts will continue during FY 1987, utilizing in-house research teams. Other in-house activities during FY 1987 include laboratory optical tests, collection and analysis of seismic profiles, and methane displacement analysis. With the knowledge gained thus far from the laboratory work, the first field tests will be conducted in FY 1986 on the North Slope of Alaska to attempt to measure gas hydrates in place using geophysical techniques. The North Slope site was chosen because of the industry

drilling data that is available that can be integrated with and help validate the data obtained. A planned second year's effort on the North Slope of Alaska to obtain surface and subsurface geophysical and geochemical measurements of suspected hydrate deposits to further define hydrate target areas and understand hydrate reservoirs will be completed during FY 1987. The Canadian government is interested in gas hydrates both as a potential hazard relative to production operations and as a potential energy source, and a draft MOU has been prepared. Interest on the part of Canada, academia, and industry will be leveraged in an attempt to pursue planned work under cooperative R&D ventures following OMB guidelines.

The deep source gas project seeks to determine whether past subduction of the oceanic plate beneath the continental plate along the U.S. west coast carried sufficient organic material and created sufficient temperature and pressure to generate large volumes of natural gas. Such a determination would impact on where exploration for gas reservoirs would be undertaken. More specifically the program seeks to establish the existence of natural gas arising from these deep source zones, establish migratory paths, determine the existence of potential gas reservoirs, define the limits of the target areas, and quantify the resource. Geological characterization tasks, initiated in FY 1984, were aimed at target definition to provide input towards resource potential and to aid in field verification of the subduction zone concept. Preliminary target areas have been identified (N. Calif., Oregon, W. Washington). These predominantly geophysical and geochemical studies utilizing in-house research teams will continue during FY 1987 to further define these target areas and thus help to determine their gas potential. During FY 1985 a new phase was initiated with the advent of experimental studies of deep gas composition, history of deep gases; and the development of a gas detection/differentiation system. Completion of these efforts will add to our knowledge of deep gas composition, identification of deep gases, and the potential for gas originating and being preserved along and adjacent to subduction zones.

An attempt will be made to solicit the cooperation, through the Cooperative R&D Venture Pool, of industry, universities, institutes and public laboratories in the pursuit of the fundamental research associated with developing a better understanding and therefore determining the development potential of the vast gas hydrate and deep source gas resources.

In-house research activities for gas hydrates and deep source gas are assigned to the Morgantown Energy Technology Center.

FTE Staffing Request

Direct FTE's are funded by this budget activity and include Federal personnel directly engaged in in-house research at the Energy Technology Centers. Although all indirect FTE's are funded in the Program Direction and Management Support budget activity, those who support the planning, management, and contract technical direction functions for this activity are included here in order to provide a clearer indication of the total Federal workforce supporting this activity.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
PROGRAM DIRECTION AND MANAGEMENT SUPPORT
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986[1/] Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Program direction and management support (FE)					
Management support:					
Headquarters program direction					
Operating expenses	$ 8,273	$13,380	$13,380	$11,260	$ -2,120
ETC program direction					
Operating expenses	37,907	39,265	39,265	28,740	-10,525
Subtotal	46,180	52,645	52,645	40,000	-12,645
The Federal Inspector for the Alaska Natural Gas Transportation System:					
Operating expenses	...	511[2/]	511	221	-290
Subtotal	...	511	511	221	-290
Total					
Operating expenses	46,180	53,156	53,156	40,221	-12,935
Program direction and management support	$46,180	$53,156	$53,156	$40,221	$-12,935
Staffing Total FTE's: Direct ...	0	0	0	0	0
Indirect .	223	249	249	191	-58

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

2/ This amount represents funding for the Office of the Federal Inspector funds appropriated under the Fossil Energy R&D account in the Department of Energy in FY 1986.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Approp.	General Reduction	Gramm-Rudman Hollings	Total
Program direction and management support (FE)				
Management support:				
Headquarters program direction				
Operating expenses.....	$14,003	$ -76	$ -547	$13,380
ETC program direction				
Operating expenses.....	41,086	-216	1,605	39,265
Subtotal.....	55,089	-292	-2,152	52,645
Institutional investment:				
Capital equipment.....	3,000	-18	-117	2,865
Alaska Pipeline Inspector.....	535	- 3	- 21	511
Construction.....	3,485	-16	-137	3,332
Subtotal, Program Direction and Management Support.....	$62,109	$-329	$ 2,427	$59,353
General Reduction:				
Operating Expenses.....	-295	-295	-	-
Capital Equipment	- 18	18	-	-
Construction	- 16	16	-	-
Total, General Reduction.....	-329	329	-	-
Total Program Direction and Management Support.....	$61,780	-	$-2,427	$59,353
Operating.....	55,329	-	-2,193	53,156
Capital Equipment.....	2,982	-	- 117	2,865
Construction.....	3,469	-	- 137	3,332

Summary of Changes

FY 1986 Appropriation enacted	$53,156
Program increases and decreases:	
Management Support	
o Headquarters program direction - decrease in funding for salaries and related expenses including SBIR assessment	-2,120
o ETC program direction - decrease in funding for site support and other overhead items	-10,525
Subtotal	-12,645
The Federal Inspector for the Alaska Natural Gas Transportation System	
o Reduce activity of the project sponsors and liaison with other project participants	-290
FY 1987 budget request	$40,221

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Management support	$52,645	$40,000	$-12,645
Headquarters program direction	$13,380	$11,260	$ -2,120

The FY 1987 funding of $11,260,000 for Headquarters program direction includes $7,178,000 for salaries, benefits and travel for 109 FTE's at Headquarters including 35 FTE's associated with general management and program support and 74 FTE's for technical program direction. The FY 1987 employment estimates assume enactment of legislation to reduce or repeal legislative employment requirements. Until the requirements are changed, the Department plans to comply with the legislative requirements regarding personnel levels.

The Headquarters staff is responsible for overall program direction. In carrying out this responsibility, the Headquarters staff: implements DOE policy and communicates that policy to the Energy Technology Centers; sets program objectives; develops program plans and evaluates alternative program strategies; develops and defends budget requests to the Office of Management and Budget and to the Congress; approves procurement plans; and monitors work progress, evaluates projects, and approves revisions in work plans as required to attain program goals.

The proper coordination and direction of the Fossil Energy program requires close and active participation by Federal personnel in contract selection and administration and requires frequent reviews by Headquarters staff with program responsibility. The complexity of the program, the geographic distribution of the research efforts throughout the U.S., and the intensive and frequent reviews necessary to manage these efforts requires constant coordination with performing organizations.

In addition, the FY 1987 request includes $4,082,000 for overhead expenses generic to the entire FE program which were financed in previous years (FY 1985 and prior) by program assessments, including $100,000 for quality assurance activities. These expenses also include printing; historically black colleges; small business innovative research program; and general management support including computer services, technical support services, conferences, etc.

ETC program direction	$39,265	$28,740	$-10,525

The FY 1987 funding of $28,740,000 provides for indirect costs at the Energy Technology Centers (ETC's) in support of day-to-day project management functions for assigned

programmatic areas. Indirect costs provide for facility operations, maintenance, finance and administrative support, and other costs not appropriately chargeable to R&D projects. In addition, ETC program direction funds provide for salaries, benefits, and travel for 250 personnel who perform indirect activities that support all Fossil Energy R&D programs. It should, also, be noted that there are 180 direct funded FTE's performing R&D work. Typical work activities performed include contract and National Laboratory monitoring; development and maintenance of project, budget, and procurement plans, and other activities related to program and site support. Funding for the direct costs (personnel and materials) of R&D work performed on-site at the ETC's is included in the various R&D program budget requests. It should be noted that in light of a restructured and reduced Federal research program carried out through the cooperative agreement with NIPER, a Bartlesville Project Office is no longer required. It is anticipated that proposed legislation will be submitted for consideration to authorize the "privitization" of the federally-owned research center located at Bartlesville.

	FY 1986 Approp.	FY 1987 Request	Net Change
The Federal Inspector for the Alaska Natural Gas Transportation System	$ 511	$ 221	$ -290

The Office of the Federal Inspector for the Alaska Natural Gas Transportation System (OFI), authorized by the Alaska Natural Gas Transportation Act of 1976, began operation in July 1979 pursuant to Executive Order No. 12142. The Federal Inspector is responsible for coordinating all Federal activities pertaining to the pipeline in order to assure timely, efficient, safe, and environmentally sound construction.

The current workload of the Federal Inspector requires a small staff (3) and consists of following the reduced activity of the project sponsors and liaison with other project participants. All field activities have been completed and field offices are being deactivated. Beginning in FY 1986, funds for the OFI were appropriated under the Fossil Energy Research and Development account in the Department of Energy for administrative support purposes.

All essential technical work will have been completed by the fall of 1985. The need for technical assistance will be minimal and on a case-by-case basis as environmental/ technical issues surface. All field offices will be closed and arrangements maintained to contract for any necessary technical services that might arise.

The primary activities of the OFI will include:

- o liaison with the sponsors, producers, other Federal agencies, the State of Alaska, and the Canadian Government;
- o the assessment of developments in the world energy market, specifically the U.S. and Canadian oil and gas situation as they affect the Alaska Natural Gas Transportation System (ANGTS). Participation in studies and other activities performed by DOE staff, other Federal agencies, the State of Alaska, or the Canadian government as they pertain to related energy transportation systems;
- o participation in Canadian and U.S. regulatory activities that could impact the remobilization of ANGTS;
- o participation in additional advance planning for Phase II; and
- o performing the routine administrative and management functions of the OFI.

As some of the these functions overlap existing DOE responsibility, the attachment of the OFI to DOE for administrative purposes will benefit both organizations by allowing closer coordination and eliminating duplication of efforts.

The FY 1987 budget request and outyear estimates reflect costs for rent, communications, and related "overhead" costs to be provided by DOE through a Memorandum of Understanding. All other object class estimates flow directly from the total number of workyears projected (3), and are based on average historical costs per workyear.

Construction of the gas pipeline itself is divided into two stages. The first stage, which was completed in the fall of 1982, involved construction of portions of the Eastern and Western Legs (referred to as "prebuild" or "Phase I" construction) to transport natural gas from Alberta, Canada. Phase I required construction of 529 miles of the system in Canada south of James River Station, 823 miles of the Eastern Leg from the U.S.-Canadian border to Ventura, Iowa, and 160 miles of the Pacific Gas Transmission System from Idaho to Stanfield, Oregon. The total 1,512 miles completed to date represents 32 percent of the entire ANGTS system.

The second phase of the projects is the completion of the Alaskan and northern Canadian portions, the Alaska Gas Conditioning Facility (AGCF), and lower 48 segments necessary to deliver the Alaskan natural gas to the continential U.S. As of April 1982, construction of this portion of the system was scheduled to be completed during the winter of 1989-90. While the Northwest Alaskan Pipeline Company (NWA) has not officially announced a new system completion date, the OFI is assuming that the pipeline will be completed sometime in the mid 1990's. The general opinion of the ANGTS participants, gas industry analysts and government regulators is that, within a few years, the gas markets will have stabilized and the financing prospects improved enough to permit the second phase of ANGTS construction to proceed.

Although the OFI foresees some additional delays in the startup of Phase II, the ANGTS project has been brought to a relatively advanced stage of planning, such that it could move forward fairly quickly when market conditions are more appropriate. All major regulatory work has been completed, except for the final FERC certificate and the State of Alaska's Right-of-Way Grant. The basic engineering is nearly to the point of final design, with the solution of the frost heave problem and approval of the Design Criteria Manuals. Given these few additional requirements, the OFI believes that pipeline construction in Alaska could begin about two years after a remobilization takes place.

FTE Staffing Request

Fossil Energy is requesting a total of 542 FTE's. Of this amount, 180 FTE's are directly funded personnel performing hands-on research and are budgeted for in each of the separate activity lead tables and are identified as "direct FTE's". The remaining 362 FTE's are financed in the Program Direction and Management Support activity in FY 1987. Of this amount, 171 FTE's are closely associated with separate program activities and can be identified as indirect FTE's within the individual programs in each separate activity lead table. Of the remaining 191 FTE's, there are 35 FTE's at Headquarters which include the immediate Office of the Assistant Secretary for Fossil Energy and his supporting budget and administrative staff; 153 FTE's support the ETC's policy and management functions and 3 FTE's support the Office of the Federal Inspector for the Alaska Natural Gas Transportation System.

The FTE request described above is summarized as follows:

	Program Direction	Direct	Total
Direct			
METC	0	73	73
PETC	0	107	107
Subtotal	0	180	180
Policy and Management			
HQ	35	0	35
METC	65	0	65
PETC	88	0	88
Alaska Natural Gas Transportation System	3	0	3
Subtotal	191	0	191
Technical Program Direction			
METC	72	0	72
PETC	25	0	25
Headquarters R&D	74	0	74
Subtotal	171	0	171
TOTAL	362	180	542

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
PLANT AND CAPITAL EQUIPMENT
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 Appropriation [1/]	FY 1987 Base	FY 1987 Request	Request vs Base
Plant and capital equipment (FE)					
Capital equipment:					
Capital equipment	$ 4,425	$ 2,865	$ 2,865	$ ...	$ -2,865
Subtotal	4,425	2,865	2,865	...	-2,865
Construction:					
GPP at ETC's	2,458	2,855	2,855	...	-2,855
METC waste water treatment fac.	2,458	...	...	...	0
METC administration wing	...	477	477	...	-477
Subtotal	4,916	3,332	3,332	...	-3,332
Total					
Capital equipment	4,425	2,865	2,865	...	-2,865
Construction	4,916	3,332	3,332	...	-3,332
Plant and capital equipment	$ 9,341	$ 6,197	$ 6,197	$ ... [2/]	$ -6,197
Staffing Total FTE's: Direct ...	0	0	0	0	0
Indirect .	0	0	0	0	0

1/ Adjustments to the FY 1986 Appropriation are shown on the table on the following page.

2/ Plant and Capital Equipment transferred from the Program Direction and Management Support activity.

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Summary of Changes

FY 1986 Appropriation enacted	$ 6,197
Program increases and decreases:	
Capital Equipment	
o No funds have been requested for capital equipment	-2,865
Construction	
o No funds have been requested for construction	-3,332
FY 1987 budget request	$ ...

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Capital equipment	$ 2,865	$ ...	$ -2,865

Capital equipment is purchased as needed to replace obsolete equipment so that the Energy Technology Centers (ETC's) and National Laboratories analytical capabilities are constantly being upgraded. New state-of-the-art diagnostic instrumentation improves in-house capabilities. Examples of such equipment are as follows: low energy electron defractor, high pressure calorimeter, calibrated blackbody radiation source, molten caustic reactor, Argon ion laser, and various types of oscilloscopes. No funds have been requested for capital equipment in FY 1987.

Construction	$ 3,332	$ ...	$ -3,332

Construction funds provide for general plant projects (GPP) at the Energy Technology Centers when needed, and are dedicated to a number of improvements, alterations and additions at each of the Energy Technology Centers. No funds have been requested for construction in FY 1987.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
COAL
FOSSIL ENERGY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Cooperative R&D ventures pool (FE)					
Operating expenses	$ ...	$ ...	$ ...	$12,500	$+12,500
Subtotal	...	...	...	12,500	+12,500
Total					
Operating expenses	...	...	...	12,500	+12,500
Cooperative R&D pool	$ ...	$ ...	$ ...	$12,500	$+12,500
Staffing Total FTE's: Direct ...					
Indirect .					

Authorization: Section 4, P.L. 93-577
Section 301, P.L. 95-91

Summary of Changes

FY 1986 Appropriation enacted	$ ...
Program increases and decreases:	
Cooperative R&D Ventures Pool	
o Initiation of cooperative R&D ventures	+12,500
FY 1987 budget request	$12,500

Cooperative R&D ventures pool:

Goals/Objectives:

Applied research and technology development efforts in Fossil Energy should strengthen U.S. technological competitiveness in the world market and achieve advancements in capability to produce energy from domestic resources, when needed, at reasonable costs with acceptable environmental and health and safety consequences.

One of the primary goals of all the applied research areas in FE is to effectively transfer technology from Federal and university laboratories to private industry. The earlier industry is involved, and the more directly that the research agenda is guided by the companies' own economic self-interest, the more effective the transfer is likely to be. A new program will be initiated in 1987, which will be in a sense a "pilot" of a transformation of much of FE's industry-performed research. This funding pool will be used to participate in industry-formed cooperative R&D ventures, as an incentive for companies to take advantage of the Cooperative R&D Act of 1984. Objectives of this new approach will be:

- o Implementation of a process by which industry will join with Government in applied research and development activities that will result in products, processes, and technology that will contribute to achieving the energy and technology goals of the United States.
- o Reduction and/or elimination of those traditional barriers that limit the financial and technical cooperation between the private and public sectors (e.g., patent positions, proprietary rights, anti-trust concerns, etc.).

Intra-industry cooperative ventures are ideally suited to this technology-transfer/proof-of-concept stage of activity. By law, and because of the competitive interests of the companies involved, their activity is restricted to pre-competitive (i.e., not product-specific) research and development. This matches Administration policy of supporting longer-term generic research that benefits the public, but not using tax dollars to subsidize a particular company's development of proprietary products. Support of industry-cooperative R&D allows limited Federal funds to strengthen a whole industry and not just one or a few selected players. This can clearly benefit emerging industries as well as more mature ones.

A cooperative venture's research agenda will be initially set by the industrial partners that form it: when DOE chooses to participate in a given venture, the companies will know that through their own willingness to invest they are having greater influence on the direction of Federal funding spending than they do in contract research. The pooled funding will also provide a greater degree of private cost-sharing for applied R&D, allowing Federal dollars to go further.

This pooling also serves as a risk sharing mechanism and Federal funding contributes to that by being more risk neutral than most private funding sources. If the cooperative venture is defined broadly, with a substantial membership base and level of funding, it can perform or sponsor technology development projects in a number of related areas. This serves to further reduce the risk to the participants, assuring better changes for shared successes that will repay each party's investment.

As a partner in such ventures, DOE will share in both decision-making and (where they exist) royalty profits from patents granted to the cooperative ventures.

The Department will not place tight constraints on the types of cooperative opportunities to be considered, but some characteristics will be considered for all proposals:

- o the factor by which Federal funding is being leveraged (in all cases, DOE should be a minority partner -- i.e., Federal funds should comprise less than half of the total funding for the venture);
- o the Department's certainty that the support they provide will not be displacing support that would otherwise come from the private sector;
- o the degree to which DOE shares in royalties or other profits from the venture, proportionate to its contribution to the venture;
- o each partnership must contain at least two companies from the same industry (to ensure that their interest will be in pre-competitive R&D); and
- o preference should be given to cooperative ventures formed by companies that have previously proven themselves successful in obtaining and managing co-funding from private sources.

DOE will aggressively seek to identify areas of cooperation by providing the forum for effective industry/industry and industry/government interfacing and through contacts with individual companies to serve as a catalyst/broker in the formulation of joint venture proposals. Incentives, aside from monetary contributions, that might be considered by the DOE as a minority partner include:

- o The use of expensive, unique government-owned facilities in addition to monitoring and technology transfer support;
- o Interfacing/assisting through U.S. Dept. of Commerce on licenses, and patent rights;
- o Serving as a vehicle/entree for tying into research being conducted in other countries; and
- o Interfacing/assisting through U.S. Dept. of Justice and U.S. Dept. of Commerce as well as public forums to avoid concerns/issues concerning any appearance of anti-trust activities.

The mechanism for the selection of ventures in which to participate will combine two key elements: (1) nomination of projects by the majority industry partners within the broad areas of research sponsored by the Department in the FE program, but especially in the area of oil, gas, or shale resources and underground coal gasification by any applicable technical route, and (2) comparison, evaluation and selection of the most effective projects using criteria consistent with the objectives of the cooperative project pool (e.g., leverage of Federal funds; creation of new and innovative activities; fostering further opportunities for continued advancement; appropriate and sound business terms for all partners; strengthening of U.S. technological competitiveness; strength and quality of venture organization and goals; and significant opportunities for ultimate return of the taxpayer investment through royalty and other forms of future profit sharing).

It is important that incentives be considered and enhanced over the range of potential projects which might be attractive to potential partners, including industrial concerns, industry associations, government or government/industry combinations in friendly nations that share a need for substitute fuels. Two major program activities anticipated to support these objectives (all of which relate essentially to making the cooperative R&D pool mechanism work as well as possible to create valuable joint venture activities) are (1) discovery and building of the consensus opportunities essential to useful joint ventures, and (2) solicitation, analysis, evaluation and other functions needed to make productive joint ventures occur.

Cooperative ventures undertaken will assure tie-in to any downstream profits resulting from application of developed technology porportionate to the DOE share in the venture.

Budget Request By Subactivity:	FY 1986 Approp.	FY 1987 Request	Net Change
Cooperative R&D ventures pool	$ ...	$12,500	$+12,500

The research and development efforts embodied in this request include recovery of gas from unconventional resources (e.g., eastern gas shales, western gas sands, gas hydrates, Arctic sources, deep sources and coalbed methane); application of advanced concepts to the removal of light oil, heavy oil and tar sands from reservoirs where present methods are uneconomical and/or ineffective; recovery of oil and energy from the Western Tertiary and Eastern Devonian and Mississippian oil shale deposits; recovery of gas from underground coal gasification; and other research and development concerning U.S. deposits of oil, gas and shale brought forth to DOE for consideration under cooperative venture arrangements ultimately to make greater use of these resources.

In FY 1986 and prior years, the Office of Fossil Energy has effectively increased the knowledge base on oil, gas, and shale technologies available to industry by supporting both technology base research and development in these areas and applied research and development which had the purpose of encouraging both evolutionary and innovative process related technology enhancements. Within the structure of this FY 1987 budget, the technology base work planned is outlined on the basis of technology areas and individual program elements. The purpose of this section of the FY 1987 budget is to describe the activity planned to make available Federal support for cooperative R&D with non-Federal entities across the whole field of oil, gas, shale, and underground coal gasification which may appeal sufficiently to private sector organizations to achieve joint venture arrangements in which the Federal Government can constructively participate as a minority partner.

The spectrum of applied research and technology development efforts anticipated in these technology and resource areas range from laboratory/bench scale activities through efforts such as field tests--precursors to actual commercial deployment and cash flow. The scale at which the research is to be conducted is anticipated to be a function of how strong an established technology base exists in the area of interest, but it must be limited to pre-competitive stages of maturity. For example, many of the unconventional gas resources of interest have not been defined well enough to develop recovery strategies with confidence. In these instances, industry and other parties could form a cooperative venture with DOE as a minor partner to develop sufficient data requisit to the next step, i.e., design and test of promising recovery concepts. A joint venture under these circumstances might entail a phased approach with an up front formulation phase and a subsequent concept analysis phase. At the other end of the spectrum, broad based industry support may be generated for pursuit of a fundamental concept for conversion of oil shale based on a strong technology base providing sufficient evidence of significantly improved economics and efficiency to warrant correlated technology development and process testing. Similarly, in the area of underground coal gasification, it is expected that the primary interest expressed will be in modest-scale pre-commercial field tests of the most promising concepts to produce the data necessary to allow the subsequent design and construction of commercial plants for the production of competitively priced medium Btu gas to be used as a chemical feedstock for conversion to any of a suite of product options. Additional interests may be expressed in the use of the technology to address otherwise unattractive coals not currently being produced because of their depth, ash content, thickness, or high sulfur content. Finally, much interest has been expressed by other countries (e.g., Brazil, Spain, and Australia) in the utilization of the UCG technology to satisfy their domestic energy needs. This interest is expected to continue and become more intense in the future. Opportunities may also exist for cooperative ventures among equipment manufacturers in other areas of coal utilization.

Wide opportunity for participation in a cooperative venture will be encouraged by working closely with industry and publically sponsored research organizations such as GRI and non-profit research institutions such as NIPER that already serve as government/industry interfaces. However, the major venture participants will ultimately decide on participants and their roles and the ventures pursued for proposal to DOE for minor limited partnership. Membership criteria or limitations will, of course, also be subject to the guidance set forth in the Cooperative R&D Act of 1984 and subsequent legal interpretations.

Further leveraging of our cooperative agreements with Venezuela, Canada, Brazil, and Mexico will be considered. Common interest in the development of recovery technologies could result in foreign countries becoming significant contributing partners up front and establishment of foreign markets for U.S. technology downstream.

The illustrative examples discussed above reflect the Department's current best estimate of areas where the private sector is most likely to express interest in joint ventures with DOE. However, it is DOE's intent to impose minimal constraints on potential proposals and to select on the basis of technical and financial merit among all proposals regardless of the specific technical area proposed for further R&D.

DEPARTMENT OF ENERGY

Proposed Appropriation Language

Naval Petroleum and Oil Shale Reserves

For necessary expenses in carrying out naval petroleum and oil shale reserves activities, including the purchase of not to exceed [3] 1 passenger motor [vehicles] vehicle, for replacement only, [$13,,668,000] $127,108,000, to remain available until expended: Provided, That section 160 of the Energy Policy and Conservation Act (Public Law 94-163, as amended) is amended (1) by striking out subsection (d); (2) by striking the phrase "subsections (c) and (d)" in each place where it occurs in subsection (e) and inserting in lieu thereof "subsection (c)", and (3) by redesignating subsection (e) as subsection (d), (Public Law 94-163, as amended). (Department of Interior and Related Agencies Appropriations Act, 1986, as included in Public Law 99-190.)

DEPARTMENT OF ENERGY

FISCAL YEAR 1987 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATION BY MAJOR ACTIVITY

NAVAL PETROLEUM AND OIL SHALE RESERVE

(Budget Authority in Thousands of Dollars)

	FY 1985 Actual	FY 1986 Estimate	FY 1987 Request
Naval Petroleum and Oil Shale Reserve	$ 195,924	$ 168,850	$ 163,569
Use of Prior Year Balances	-39,000	-155,848	-36,461
Savings From FY 84 Initiatives	-50	---	---
Total, Naval Petroleum and Oil Shale Reserve	$ 156,874	$ 13,002	$ 127,108
Revenues	$-846,038	$-831,152	$-1,011,809

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
PROGRAM OVERVIEW

Naval Petroleum and Oil Shale Reserves

The Naval Petroleum and Oil Shale Reserves consist of three petroleum and three oil shale reserves established in a series of Executive Orders between 1912 and 1924 to provide an emergency source of liquid fuels for the armed forces. Subsequently, the Congress endorsed the establishment of the Reserves and provided authority for their operation through a series of laws now codified in Title 10, United States Code, Chapter 641.

Pursuant to the Naval Petroleum Production Act of 1976, the three petroleum reserves are being produced at their maximum efficient rates, and presently, the produced petroleum is sold either competitively in the open market or to the Department of Defense (DOD). Such production is authorized through April 5, 1988.

Since 1976, Congress and three successive Administrations have pursued a policy requiring that oil, natural gas and other hydrocarbons at the NPR's be produced and sold; that the proceeds from the sale be used to reduce the Federal budget deficit; and that the nation's emergency petroleum needs be assured by building up the Strategic Petroleum Reserve (SPR). The SPR today contains 499 million barrels of oil. As Congress foresaw in 1976, a superior source of oil for emergencies has been created. SPR can pump oil at 3 million barrels per day -- 30 times faster than the NPR's. Legislation was enacted in 1984 to simplify the Department of Defense petroleum procurement, one of the original motivating factors behind the establishment of NPR, and in addition, the overall energy situation has significantly improved.

The Administration is now proposing that the next logical step be taken with respect to the NPR's. Legislation will be submitted at a later date which will propose that Federal ownership interests in the NPR's 1 and 3 be offered for sale outright, under a competitive situation, to the highest bidder. This policy is to designed to assure that the fields are produced as efficiently as possible and also assure that the government receives maximum value from the fields. The purchaser would be subject to Windfall Profits Tax as well as corporate income tax requirements. The Administration looks forward to discussing this proposal in detail with members of Congress and staffs.

The rest of this document describes the program needs, assuming that the NPR's are operated through the end of the fiscal year. This request totals $163,569,000, offset by $36,461,000 of prior year balances carried forward, for a net appropriation request of $127,108,000. Any unused appropriated funds remaining after the sale would be proposed for recission.

The primary development programs at both Reserves have been completed. This has resulted in a shift of programmatic emphasis to operation and maintenance activities as opposed to large development programs. This accounts for relatively level drilling and facility programs. At such time as the application of enhanced oil recovery techniques is proven to be technically and economically viable, large development funding may again be requested.

Initial development drilling has essentially been completed at NPR-1 and 3 in known hydrocarbon bearing formations. A major infill drilling program is proposed for the eastern flank of the Shannon reservior at NPR-3 where

it has been determined that EOR techniques are not feasible. The major drilling program emphasis is directed at maintaining maximum efficient production of the reserviors. No major facilities projects are planned at either NPR-1 or NPR-3 in FY 1987. This budget provides final funding for the protection against Naval Oil Shale Reserves No. 3 (NOSR - 3) gas migration to private lands.

The Government's share of crude oil produced from the Reserves, which is estimated to be 104,000 barrels of oil per day (BOPD) in FY 1986 and 91,000 BOPD in FY 1987, is sold on the open market to the highest competitive bidders and to the DOD under a petroleum transfer agreement. The bulk of natural gas produced at the Petroleum Reserves is reinjected into the oil-bearing formations to maintain reservior pressures and production. The surplus gas, about 160 million cubic feet per day (MMCF/D)in FY 1986 and 150 MMCF/D in FY 1987, and the 620,000 gallons per day (G/D) of liquid products in FY 1986 and 525,000 G/D in FY 1987 obtained from processing the natural gas, are presently sold through competitive sales to the highest qualified bidders. Revenues from all sales in FY 1985 were about $1.3 billion, including Windfall Profits Tax receipts.

NPR-1, Elk Hills, located near Bakersfield, California, is currently operated under a unitization agreement (Unit Plan Contract) between the Government and Standard Oil Company of California (Chevron U.S.A. Inc.). Under this agreement, the Government establishes the rate of production but all exploration, prospecting, development and producing operations on the Reserve are carried on under the supervision and direction of a two-member Operating Committee consisting of one Government member and one Chevron member. The Unit Operator, Bechtel Petroleum Operations, Inc., is under a 5-year cost-plus-award-fee contract with the Government which began August 1, 1985. Total production at NPR-1 in FY 1985 was 131,000 BOPD, 370 MMCF/D of natural gas and 680 MGAL/D of liquid gas products. Production is expected to average approximately 128,000 BOPD in FY 1986 (Government share 101,000 BOPD), 375 MMCF/D of natural gas and 700 MGAL/D of liquid gas products. In FY 1987, production is estimated at 113,000 BOPD (Government share 88,000 BOPD), 335 MMCF/D of natural gas and 590 MGAL/D of liquid gas products. The Government share of production varies by zone, averaging approximately 78 percent of total production.

Receipts from the sale of petroleum and related products are transferred to the U.S. Treasury and deposited either in the Miscellaneous Receipts or the Windfall Profits Tax accounts. Total gross receipts were about $1.3 billion in FY 1985, and are estimated to be $1.2 billion in FY 1986. It is estimated that revenues will decrease to $1.1 billion in FY 1987, with declining production and oil prices -- $24.52 per barrel in FY 1986 and $24.05 per barrel in FY 1987. Pursuant to Section 1611 of the DOD Authorization Act of 1986, P.L. 99-145, there is a one-year extension for the transfer of 30 percent of net revenues from the Reserves for FY 1986, approximately $284 million, to be deposited into the National Defense Stockpile Transaction Fund. Windfall Profit Taxes were $161 million in FY 1985, and are estimated to be $138 million in FY 1986 and $93 million in FY 1987. Chevron reimburses the Government for its share of the costs for Unit operations at NPR-1, contributing approximately $24 million of such costs in FY 1985, which was deposited in the Miscellaneous Receipts account. Chevron's share of unit operation costs, included in the revenue estimates above, is estimated to be $28 million in FY 1986 and FY 1987. Additional revenues of approximately $4 million per year are deposited in the Miscellaneous Receipts account from NPR-2 lease royalties and pipeline usage fees.

The current development and exploration programs were initiated at NPR-1 in FY 1975. Since that time, 985 development wells and 38 exploratory wells have been drilled. An additional 46 development wells are scheduled for FY 1986, and 35 development wells are planned for FY 1987. Exploration of the highest potential payoff target zones will be continued in FY 1987.

The Development Facilities category is an ongoing element of the NPR-1 program, meeting construction and modification requirements in response to changing field conditions. As the field matures, changes in reservoir pressures and increasing amounts of gas and water are being encountered. The facilities requested are needed to maintain the field's maximum efficient rate of production, and enhance ultimate recovery.

NPR-3, Teapot Dome, located near Casper Wyoming, produced an average of 2,900 BOPD, 8 MMCF/D of natural gas, and 14 MGAL/D of liquid gas products in FY 1985. Production is estimated to average 2,800 BOPD in both FY 1986 and FY 1987. Secondary recovery projects are anticipated to sustain and/or increase production. Natural gas and liquid gas products will also remain level in FY 1986 and FY 1987 at 10 MMCF/D of natural gas and 15 MGAL/D of liquid gas products. Increased production due to EOR is not expected to affect production until FY 1989. Revenues at NPR-3 totaled $31 million in FY 1985, and are estimated to be about $30 million in FY 1986 and $29 million in FY 1987, subject to changes in petroleum prices and actual reservoir performance.

A program to fully develop NPR-3 was initiated simultaneously with open-up in FY 1976. The drilling program has resulted in 539 development wells drilled since that time. Twenty development wills are scheduled for FY 1986 with 52 wells planned for FY 1987. The FY 1986 program provides for a development effort of the deeper zones. This program will be continued in FY 1987. In an effort to increase production from the eastern flank of the Shannon reservoir, which is not amenable to EOR, an infill drilling program will be initiated, consisting of 30 wells in FY 1987. As many as 90 additional infill wells could be drilled in future years, if shown to be economical. The contractor operator at NPR-3 is Lawrence-Allison and Associates West Inc., which is under a 5-year cost-plus-award-fee contract through September 30, 1986. Proposals will be solicited during FY 1986 for a subsequent 5-year management and operating contractor. Selection of a contractor is anticipated in June 1986.

The EOR program at NPR-3, in FY 1987, will allow for continued operation and maintenance of the pilot projects, except for the oxygen-enhanced in-situ combustion pilot project, which has not proved to move sufficient amounts of oil to justify its continued operation. The remaining pilots will be evaluated during FY 1987 for broader implementation in FY 1988, if technically and economically feasible. This plan allows for verification of pilot results before the major expenses of full-scale development are incurred. Successful field-wide application of either of the EOR technologies to the entire Shannon Reservoir could increase the amount of recoverable oil from the present 5 percent to 20 percent of the 180 million barrels of original oil-in-place over the life of the reservoir.

To protect the natural gas resources at NOSR-3 from drainage by commercial development adjacent to the Reserve, offset drilling was begun in FY 1984 and continued through FY 1986 along the NOSR-3 southeastern boundary. The drilling program will complete the NOSR-3 gas protection plan as now envisioned. Revenues generated from the sale of natural gas produced from the offset wells are estimated at $1.6 million in FY 1986 and $5.6 million in FY 1987. Land management activities will be continued at all the NOSRs. This includes grazing management, road maintenance, and fence maintenance and construction, to be carried out under interagency agreement with the Bureau of land Management (BLM). These funds also provide for annual operation and maintenance fees for rights to water stored in BLM's Ruedi Reservoir.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
FOSSIL ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES

(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 APPROPRIATION	FY 1986 APPROPRIATION	FY 1987 BASE	FY 1987 REQUEST	REQUEST vs. BASE
Reserves Nos. 1 & 2 (California)					
Operations & Maintenance	$107,215	$ 94,843	$ 94,843	$ 95,640	$ + 797
Development Drilling	20,000	17,900	17,900	22,900	+5,000
Development Facilities	33,973	8,000	8,000	8,000	---
Exploration Drilling	10,000	9,900	9,900	3,800	-6,100
Subtotal	$171,188	$130,643	$130,643	$130,340	$ - 303
Reserve No. 3 (Wyoming)					
Operations & Maintenance	$ 14,374	$ 20,086	$ 20,086	$ 15,610	$ -4,476
Development Drilling	2,245	3,950	3,950	6,754	+2,804
Development Facilities	1,250	5,047	5,047	250	-4,797
Subtotal	$ 17,869	$ 29,083	$ 29,083	$ 22,614	$ -6,469
Naval Oil Shale Reserves					
NOSRs 1 & 2	$ 990	$ 104	$ 104	$ 60	$ - 44
NOSR-3	338	3,593	3,593	5,181	+1,588
Subtotal	$ 1,328	$ 3,697	$ 3,697	$ 5,241	$ +1,544
Program Direction					
Headquarters	$ 1,671	$ 1,448	$ 1,448	$ 1,664	$ + 216
Reserves Nos. 1 & 2	3,170	3,244	3,244	2,875	- 369
Reserve No. 3 & NOSRs	698	735	735	835	+ 100
Subtotal	$ 5,539	$ 5,427	$ 5,427	$ 5,374	$ - 53
SUBTOTAL	$195,924	$168,850	$168,850	$163,569	$ -5,281
Use of Prior Year Balance	- 39,050	-155,848	-155,848	-36,461	$+119,387
TOTAL	$156,874	$ 13,002 1/	$ 13,002	$127,108	$+114,106
Staffing Total FTE's	104	104	104	95	-9

Authorization: P. L. 94-258

1/ Adjustments to the FY 1986 appropriation are shown on the table on the following page.

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Conference	General Reduction	G-R-H Reduction	Total
Naval Petroleum Reserve				
Reserves Nos. 1 & 2 (California)				
Operations & Maintenance	$ 95,000	$-64	$- 93	$ 94,843
Development Drilling	17,900	-	-	17,900
Development Facilities	8,000	-	-	8,000
Exploration Drilling	9,900	-	-	9,900
Subtotal	130,800	-64	- 93	130,643
Reserve No. 3 (Wyoming)				
Operations & Maintenance	20,187	-14	- 87	20,086
Development Drilling	3,950	-	-	3,950
Development Facilities	5,047	-	-	5,047
Subtotal	29,184	-	- 87	29,083
Naval Oil Shale Reserves				
NOSR-1	110	- 1	- 5	104
NOSR-3	3,754	-	-161	3,593
Subtotal	3,864	- 1	-166	3,697
Program Direction				
Headquarters	1,515	3	- 64	1,448
Reserves Nos. 1 & 2	3,387	-	-143	3,244
Reserve No. 3	766	-	31	735
	5,668	- 3	$-238	$168,850
Subtotal, Naval Petroleum Reserve.....	$169,516	$-82	$-584	$168,850
General Reduction: Operating Expenses	-82	+82	-	-
Use of Prior Year Balances (NPR)	-155,848	-	-	-155,848
Total, Naval Petroleum Reserve	$ 13,586	-	$-584	$ 13,002
Operating Expenses	13,586	-	-584	13,002

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF CHANGES
NAVAL PETROLEUM AND OIL SHALE RESERVES
(In thousands of dollars)

FY 1986 Appropriation Enacted	$ 13,002
FY 1987 Base	$ 13,002
Reserves Nos. 1 & 2	
- Operations & Maintenance Increase due to type of remedial jobs planned and labor costs.	+ 797
- Development Drilling Increase due to greater number of deeper, more expensive Stevens Zone wells.	+ 5,000
- Exploration Drilling Decrease due to less expensive well planned in FY 1987.	- 6,100
Subtotal	$ -303
Reserve No. 3	
- Operations & Maintenance Decrease due to reduced enhanced oil recovery, pilot project activity and administrative costs.	- 4,476
- Development Drilling Increase due to initiation of Shannon infill drilling program.	+ 2,804
- Development Facilities Decrease due to completion of pilot EOR projects in FY 1986, and no major facility requirements in FY 1987.	- 4,797
Subtotal	$- 6,469
Naval Oil Shale Reserves	
- NOSRs 1 & 2 Decrease due to closure of Anvil Points.	- 44
- NOSR-3 Increase due to type of wells required to complete gas protection plan, their operating and maintenance costs, and for mitigation of adverse environmental conditions at Anvil Points.	+ 1,588
Subtotal	$+ 1,544

Program Direction

- Headquarters Increase due to Federal salary adjustments and military reimbursement.	+ 216
- Reserves Nos. 1 & 2 Decrease due to reduction in FTEs.	- 369
- Reserve No. 3 & NOSRs Increase due to Federal salary adjustments and military reimbursement.	+ 100
Subtotal	$ - 53
Total	$ 7,721
Use of Prior Year Balance	$+119,387
FY 1987 Budget Request	$ 127,108

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
Reserves Nos. 1 & 2 (California)	$130,643	$130,643	$130,340

The FY 1987 budget request for the Naval Petroleum Reserves in California (NPR-1 & 2) is $130,340,000, a decrease of $303,000 from FY 1986. This request provides funding for Operations & Maintenance ($95,640,000), Development Drilling ($22,900,000), Development Facilities ($8,000,000) and Exploration Drilling ($3,800,000). Operations and Maintenance continues fairly level funding from FY 1986, reflecting stable operations and requirements. A total of 676 unit operator personnel will be funded in FY 1987.

The Development Drilling program will also continue at a relatively stable level, reflecting a more selective well identification schedule, and continued implementation of secondary recovery programs. The planned program includes 5 water injection/disposal wells and 30 production wells. Development Facilities provides for continued modifications and minor construction projects necessary to meet field production requirements. Exploration Drilling funds provide for one well in FY 1987.

Operations and Maintenance	94,843	94,843	95,640

The FY 1987 budget request for Operations and Maintenance supports day-to-day field activities necessary to continue the maximum efficient rate of production. The amount requested for FY 1987 represents level funding from FY 1986 and stabilization of operations.

a) Business Management	20,008	20,008	19,100

Business Management provides for administrative type activities of the Unit Operator. This includes financial, accounting, legal, secretarial, and related service support. In addition, it includes the purchase of safety equipment, office supplies, contractual automated engineering services, security, safety and environmental licensing, employee services and in-house ADP. A total of 226 contractor personnel are funded in this category. The decrease is attributed to reduced project funding requirements for ADP equipment.

b) Operations Management	40,405	40,405	39,040

This category funds field operations including Gas Operations and Maintenance, Production Operations and Maintenance, and Drilling Supervision. Responsibilities include operating and maintaining all production facilities, gas processing plants and supervising the development and exploratory drilling programs. Funds will provide for 310 contractor personnel in this area.

Examples of these activities include the following:

- maintenance and repair of 350 miles of pipelines, 75 tank settings, valves, pumps, gas compressors, storage tanks, etc., used in the collection, storage and distribution of oil and gas;

- production of fresh water, disposal of waste water, and the operation of the waterflood injection systems;

- surface and downhole well work as needed for approximately 1,300 producing and injection wells;

- operation and maintenance of steam operations in the Tulare Zone;

- vehicle maintenance, rental, and replacements; and

- operation and maintenance of three gas plants which process approximately 350 MMCF/D, gas injection wells (200 MMCF/D), field compressor units, dry gas facilities, and the liquid products loading rack.

The decrease in the FY 1987 request is due to continued increases in operational efficiencies and increased productivity.

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
c) Engineering Management	$19,510	$19,510	$19,100

Engineering Management provides for technical contract services such as facility and petroleum engineers, and funds services such as drafting, construction, and telecommunications not charged to specific jobs. Also included are costs for cathodic protection, corrosion control, laboratory services, gauging, core storage, electricity, electrical maintenance, reservoir engineering and geological studies. A total of 140 contractor personnel are funded in this area.

The FY 1987 request reflects a decrease due primarily to a reduction in services related to facility modifications and construction.

d) Remedials	10,920	10,920	14,400

The Remedial budget supports major well work required to maintain existing wells in optimum producible condition and provides for recompletions; casing failures; sand consolidation; injection profile control; gas/oil ratio control; well stimulation measures; artificial lift; waterflood injectors; abandonments; and tubing replacements. The number of wells estimated to require some type of remedial program in FY 1987 is 166.

The estimate is based upon the following:

- stimulation work to remove well-bore damage and increase production (51 wells);

- well stimulation and recompletion work in connection with expanded waterflood and EOR operations (30 wells);

- remedial operations required to control excessive gas/oil ratios for Stevens wells in pressure maintained reservoirs (10 wells);

- abandonment of wells no longer capable of production (21 wells);
- tubing replacements (5 wells);
- control of excessive sand, water and gas entries (7 wells);
- well workovers, tubing, piping, electrical line hook-ups and site preparation necessary for the installation of artificial lift in Stevens Zone wells (42 wells);

The requested increase for FY 1987 is due primarily to the increased downhole work and equipment installation. (Artificial lift pumping units are funded out of Development Facilities). The average payout period for remedial jobs is estimated at less than 6 months. It is noted that the total number of well programs for subsurface artifical lifts (42) is greater than the total of artificial lifts purchased (30) under Development Facilities. This is because artificial lift equipment is salvaged from uneconomic wells, wells which may return to a flowing condition, wells converted to injection. Also, under the rod pumping unit optimization program, large sized units are replaced by surplus smaller units on Shallow Oil Zone wells and the large units are placed on Stevens wells.

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
e) Operator Fee	$4,000	$4,000	$4,000

The Operator Fee consists of a combination of base fee and award fee paid to the management and operating contractor of the two Reserves in California. Both base fee and award fee are negotiated annually, and the latter actual award amount is based on evaluation of performance. The FY 1987 request represents the best estimate of such fees to be negotiated based upon level of effort.

Development Drilling	17,900	17,900	22,900

This category funds the drilling of development wells at NPR-1. Specific objectives to be accomplished with the FY 1987 drilling program include: (1) additional wells necessary to enhance Stevens Zone production, both from primary and waterflood recovery in the Main Body B, Northwest Stevens, and 24Z pools; (2) develop the potential production from shale in the 31S structure; (3) in the western portion of the Reserve expand development of the SOZ sands; (4) drill preliminary wells necessary to initiate an SOZ waterflood project in Section 1G-12G; and (5) drill additional water disposal wells in the Tulare to handle increasing volumes of water. The FY 1987 drilling program is distributed by zone and unit cost as follows:

Zone & Type	No. of Wells	Unit Cost	Total Cost	Estimated Production (BOPD)	Revenues Annualized ($000)
Tulare (water disposal)	2	$ 126	$ 252	---	$ ---
Shallow Oil Zone (water injection-2) (producers-7)	9	258	2,322	245	2,287
Stevens Shallow (producers-21) (water injection-1)	22	817	17,974	3,150	29,411
Stevens Deep (producers)	2	1,176	2,352	300	2,801
TOTAL	35		$22,900	3,695	$34,499

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
Development Facilities	$8,000	$8,000	$8,000

This category provides funding for facility modifications and construction needed to support continued production and development of the field. This request includes facilities to adapt to changing field conditions, respond to environmental and safety requirements, and provide support for secondary and enhanced recovery activities. This request is the same as funding for FY 1986, reflecting a stabilization of operations.

a) New Facilities	6,552	6,552	6,130

1. Artificial Lift ($4,883,000)

   Due to the response of waterfloods and declining reservoir pressures, it will be necessary to continue installation of additional artificial lift equipment in an estimated 30 Stevens wells in FY 1987 to maintain oil production. Total estimated cost is $4,883,000.

   Funds will be used to purchase variable speed electric submersible pumping units in 20 Stevens wells, mainly in the 31S Structure. Equipment to be purchased includes 150 hp multi-stage, variable speed, high voltage (approximately 2,900 VAC) centrifugal submersible pumps, equipped with gas separators and seal sections, pump cable, wellhead, control panel, and transformers.

   Also to be purchased are standard rod pumping units and related equipment for 10 Stevens wells located in the 29R, NWS, 24Z and 26R structures. Equipment to be purchased includes rod pump, beam-type pumping unit with 50 hp electric driver, concrete base, electric controls, and transformers.

2. Shallow Zone (SOZ) Waterflood Project ($832,000)

   Install pipelines and filtering equipment to waterflood the southeast flank of the SOZ. Through technical analyses, water injection is considered applicable to enhance maximum ultimate recovery from this major producing zone at NPR-1.

3. Install Water Storage Tanks ($415,000)

Water supplies in remote areas of the Reserve are nil. In the event a fire at a tank setting or major crude oil ground spill from a pipeline or tank occurs, water would have to be trucked in by vacuum truck or county pumpers. Consequently, the risk of property loss is extremely high without adequate water supply. It is planned that several 5,000 barrel water tanks would be located along the pipeline carrying fresh water produced from the Tulare Zone for waterflood injection. The Kern County Fire Department would then have ready access to water.

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
b) Modifications/ Improvements	$1,448	$1,448	$1,870

1. Increase Fluid Handling Capacity at 1-7R Tank Setting ($405,000)

In response to the NW Stevens waterflood, total fluid handled at 1-7R tank setting will exceed the tank setting's present capacity (approximately 18,000 barrels of fluid per day (BFPD) during FY 1988. If storage, pumping and separation facilities are not expanded, production would be severely restrained.

Facilities to be installed will include a 2,000 barrel welded surge tank with vapor recovery equipment, 3 shipping pumps, one additional separator train, interconnecting piping, and modifications to the electrical power and control system.

2. Reduce Exhaust Emission from Gas Compressors ($415,000)

Because Kern County was unable to meet federal air pollution control standards by the end of 1982, they must implement additional control measures. Steam vent casing controls and refinery flange inspection regulations have already been imposed, and several additional measures are being evaluated for adoption in 1986, and implementation in 1987. The measure that is most likely to be adopted is the requirement to reduce hydrocarbon emissions on internal combustion engines by 50 percent.

This will require a combination of catalytic convertors, air injection and carburetion changes. The projected costs for this project includes the addition of catalytic convertors plus carburetor modifications to 8 field compressors.

3. Unscheduled Facilities ($1,050,000)

Based on field experience, funding is required to respond to changes in reservoir pressure; producing rates of oil, water and gas; gas injection and waterflood requirements and environmental and safety requirements with facility modifications which cannot be identified at this time. The types of unscheduled facilities modifications generally required include the following:

1) Waste Water Disposal System
2) Oil Collection System
3) Gas Collection System
4) Tank Setting Manifolds
5) Environmental, Safety and Fire Protection

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
c) Replacement	$ ----	$ ----	$ ----

No funds are requested for this category in FY 1987.

Exploration Drilling	9,900	9,900	3,800

The FY 1987 budget requests funding to provide for one exploratory well which has the potential of finding additional oil. A number of exploratory wells have been drilled to the Carneros, a producing zone at Elk Hills, hoping to find new pools of commercially producible hydrocarbons. Generally, these wells are drilled through the Stevens zone, in hopes of finding a structure in the Carneros which correlates to the Stevens structure above, which is capable of trapping hydrocarbons. If hydrocarbons are not found in the Carneros, the well is completed in the Stevens. Using this approach, an exploratory well was drilled in 1984 to evaluate the potential of the Carneros in the Northwest Stevens area. The well penetrated good, thick, Carneros sand with some good gas shows, but was not commercially producible. At a cost of $3,800,000, it is proposed to drill another Carneros exploratory well in this area in a better structural position. The well will be located further west southwest (less than 1 mile) and up dip in hopes of discovering new production. Preliminary evaluation of geophysical information in the area shows a potential Carneros accumulation of 30 MMCF of gas and 1.5 million barrels of condensate.

Reserve No. 3 (Wyoming)	29,083	29,083	22,614

The FY 1987 budget request for the Naval Petroleum Reserves in Wyoming (NPR-3) is $22,614,000 and provides funding for conventional oil field operations and secondary and enhanced oil recovery (EOR) activities within the areas of Operations and Maintenance ($15,610,000), Development Drilling ($6,754,000), and Development Facilities ($250,000). The FY 1987 request is a decrease of $6,469,000 from FY 1986, primarily due to reduced costs and requirements for secondary and enhanced recovery pilot projects. Operations and Maintenance shows a decrease reflecting a variety of changes in the field which are described in the O&M section, and pilot projects; Development Drilling increases are due to additional wells being drilled in the deeper zones and the initiation of a Shannon infill drilling program; and Development Facilities decreases due to completion of the construction phase of the EOR pilot projects. A total of 193 contractor/operator personnel will be funded in FY 1987, maintaining the same level as in FY 1986.

Operations and Maintenance	20,086	20,086	15,610

Operations and Maintenance provides funding for the day-to-day activities necessary to produce an oil field.

a) Production Operations and Maintenance	9,610	9,610	6,680

This activity provides funding for all production activities including supervision, labor, supplies and materials necessary to operate, maintain and repair all producing wells, petroleum and gas facilities. Included are the following:

- Petroleum handling facilities including treating, storage, pumping, flowline, gathering, sales and testing facilities.

- Gas collection, processing and injection facilities including injection wells, gathering and compression systems, distribution and sales systems, vapor recovery system and the Low Temperature Separation (LTS) plant.

- Waterflood facilities including the water well, processing and pumping facilities, distribution facilities, injection wells and remedial work.

- Maintenance, repair, and fuel for all DOE owned heavy field equipment including two vacuum trucks, a hot oil truck, two winch trucks, backhoe, forklift, grader, bulldozer, welding truck, paint truck, and trencher.

- Routine servicing and maintenance of all producing wells. This includes replacement of tubing, rods and bottom-hole pumps; maintenance and repair of surface equipment and pumping units; minor well stimulations and clean-outs; and bottom-hole pressure tests. Approximately 35-40 wells will be serviced each month.

- Chemical treatment program for the treatment of produced oil, waterflood bacteria control, scale and corrosion inhibition and paraffin control.

- Ninety-two contractor/operator personnel.

- Operation, maintenance, monitoring and analysis activities related to the EOR polymer-enhanced waterflood pilot program, and the EOR steam drive project.

The decrease in the FY 1987 request reflects a reclassification of the operation of the DOE drilling rig #1 to Development Drilling ($600,000); discontinuation of the use of the slant hole drilling rig ($240,000) as deviation drilling with the DOE rig has proven to be more cost effective; elimination of in-situ combustion pilot operation and maintenance activities ($1,450,000) as the project has not proven to be economically or technically efficient; reduced operation and maintenance requirements for the polymer waterflood pilot ($250,000) as injection of polymer has been completed and the project is in a waterflood phase; reduction in planned well stimulations ($350,000) to approximately 15 per month as engineering evaluations have determined this to be the proper level now required; and minor miscellaneous items such as supplies and equipment ($40,000).

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
b) Buildings/Utilities/ Roads	$1,209	$1,209	$1,252

This activity provides funding for the maintenance and repair of all buildings, storage areas, utility systems, roads and grounds, including snow removal, fences, bridges, revegetation, field clean-up, trash disposal, oil spill containment, and the electrical power required to operate the field facilities and equipment.

The increase requested for FY 1987 reflects an adjustment for inflation.

c) Equipment	210	210	---

This category provides funding for the purchase of heavy field equipment in support of oil field operations. The FY 1987 request includes no requirement for replacement equipment.

d) Management and Technical Services	3,556	3,556	3,287

This activity provides funding for project management, engineering and geological support, corporate headquarters assistance, reservoir studies and 41 contractor/operator personnel.

Project management provides overall management of operations, including field operations, EOR analyses, technical services, scheduling, planning and training. It covers such activities as technical surveillance, cost management, quality assurance and compliance with local, state, and Federal laws and regulations. Engineering and geological support provides needed expertise in petroleum geology, reservoir engineering, EOR, drilling and production engineering and design/construction engineering. This includes such activities as analyzing production operations; developing proposals, cost estimates and designs; developing individual well procedures; and maintaining up-to-date well files and structure maps. Reservoir studies are required for analysis of the various reservoirs to optimize ultimate recovery by ensuring application of the appropriate production techniques.

The decrease in the FY 1987 request is due to more efficient operations and costs reductions imposed upon the contractor/operator in such areas as personnel, travel and training.

e) Administrative Services	3,475	3,475	3,035

This activity provides for operation of the management information system (MIS) and supporting input data control for accounting, contracts/procurement, and property management. It also includes rental of space and vehicles, office materials and supplies, liability insurance, corporate overhead, field safety, security, health and environmental protection, and 42 contractor/operator personnel.

The decrease for FY 1987 includes reduced contractor costs in personnel related areas ($300,000), reduced security costs as it has been determined that a roving guard is no longer required ($125,000), offset by a small inflation adjustment for supplies ($15,000).

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
f) Operator Fee	$2,026	$2,026	$1,356

This category provides funding for the operator fee portion of the cost-plus-award fee contract under which operations of the Reserve are conducted. Under the terms of this contract, the operator receives a fixed base fee and an award fee determined each quarter by evaluation of performance. The decrease in the FY 1987 request reflects new procurement policies in which certain subcontracting and other costs are excluded from the fee base.

Development Drilling	3,950	3,950	6,754

Development Drilling provides funding for drilling and completing development wells, installing flowlines and electrical connections for these wells and labor costs for 18 contractor/operator personnel. The drilling program requested is based on penetration of the deepest potentially productive horizon to maximize drainage of all productive zones and in-fill drilling targeted at the shallow Shannon reservoir. Deeper drilling during FY 1984 revealed additional potential producing horizons in several formations, and extensive faulting has been shown to provide isolated, untapped accumulations adjacent to existing production. As specified by the present development policy, the normal development drilling plan targets deeper wells, commonly called "Morrison wells" or "Morrison-depth wells". This terminology indicates that the wells are drilled into the top of the Morrison formation, which is used as a marker to ensure that both the Dakota and Lakota zones have been fully penetrated. Although oil shows are occasionally encountered in the Morrison zone, previous completions have led to the decision that the Morrison is non-commercial. These wells are expected to add an approximate total of 530 BOPD to NPR-3 production, and will be drilled with the existing DOE Rig No. 1 over the period of a year.

The in-fill drilling program for the shallow Shannon reservoir consists of the drilling, completing, and hookup of 30 wells. It will yield increased primary reserves in a portion of the Shannon reservoir which is not amenable to EOR or other displacement processes. EOR does not appear to be practical in this portion of the reservoir due to

production. Since the average depth of the in-fill wells will be 500 feet, they will be inexpensive and will take two to three days each to drill and complete. The 30-well program is expected to have a payback of 12 months assuming 10 BOPD/well, and yield a Net Present Value of $6,000,000 based on a five-year cash flow and 15% discount rate.

Zone	No. of Wells	Unit Cost ($000)	Total Cost ($000)	Total Estimated Production (BOPD)	Projected Annualized Revenues ($000)
Shannon (in-fill)	30	$ 90	$2,700	300	$2,956
Second Wall Creek (in-fill)	18	175	3,150	450	4,435
Lakota-Dakota	4	226	904	80	788
Total	52		$6,754	830	$8,179

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
Development Facilities	$5,047	$5,047	$ 250

Development Facilities provides funding for facilities projects necessary to continued development of the field by maintaining current production or recovering oil which cannot be produced by primary production methods. The FY 1987 request is for $250,000, a decrease of $4,797,000 from FY 1986. This request provides funding for Shannon Reservoir engineering and design funds.

a) New Facilities — 5,047 — 5,047 — 250

1. Shannon Production Enhancement Project ($250,000)

Shannon EOR projects will be evaluated, field and modeling tests for the Shannon Oil Drainage project will be conducted, and economic analyses will be performed on each of these production methods during FY 1986. The most cost effective method, or methods, will be chosen for expansion in FY 1987. These funds will provide for the final designs, plans, specifications, and cost estimates. Construction funds, if any, will be included in the FY 1988 Budget Request.

The desired benefits of these projects are to provide adequate plans and designs to increase economically recoverable oil in the Shannon reservoir. The design would start during the third quarter of FY 1987 and be completed during the fourth quarter of FY 1987.

b) Modifications/ Improvements — --- — --- — ---

No funds are requested for this category in FY 1987.

c) Replacement — --- — --- — ---

No funds are requested for this category in FY 1987.

	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
Naval Oil Shale Reserves	$3,697	$3,697	$5,241

The FY 1987 budget request for the Naval Oil Shale Reserves (NOSRs) is $5,241,000, an increase of $1,544,000 over FY 1986. Funding is requested for resource protection and maintenance activities. Included in this request is funding to drill 6 offset wells at NOSR-3, operation and maintenance of 14 NOSR-3 gas wells, environmental activities and land management for all the NOSRs.

NOSRs 1 & 2	104	104	60

The FY 1987 budget request for NOSR-1 is $60,000, a decrease of $44,000 from FY 1986. The decrease is due to decommissioning of the Anvil Points facility, eliminating minor maintenance and security requirements at that site. The FY 1987 request provides for the annual operation and maintenance fee paid to the Bureau of Land Management to reserve water from the Ruedi Reservoir ($10,000), and continued land management activities at the NOSRs ($50,000).

NOSR-3	3,593	3,593	5,181

The FY 1987 budget request for NOSR-3 is $5,181,000 which provides for the drilling of 6 offset gas wells, operations and maintenance to protect the natural gas resources underlying NOSR-3, and environmental activities at Anvil Points. Planned for drilling are 3 Wasatch wells at a unit cost of $420,000, and 3 Mesaverde wells at a unit cost of $1,143,000. Based on current drilling rates and costs for required supplies and equipment, total drilling costs are estimated to be $4,829,000. This includes site preparation, completion and installation of gathering lines to deliver the natural gas to sales and shipping points. Additionally, funding of $102,000 is requested to provide operations and maintenance for the 14 wells. A total of 6 contractor personnel will be funded to carry out the drilling and maintenance activities. This request completes the 14 well plan designed to protect the southeastern portion of the NOSR-3 boundary adjacent to development by private industry. Should expansion of off-site drilling by private industry occur, it may become necessary to drill additional wells in the future to protect the remaining NOSR-3 boundary against the migration of natural gas.

Included in this request is $250,000 for the mitigation of adverse environmental conditions stemming from the spent oil shale pile at Anvil Points. Contingent upon the results of an environmental assessment to be performed in FY 1986 and Federal, state and local regulatory requirements, certain activities may be required for the spent oil shale pile. These could include groundwater monitoring, maintenance of the retention pond, maintenance of the water and pumping system or others.

Program Direction	5,427	5,427	5,374

This request provides funding to support 95 Full-Time Equivalents (FTE's) required to plan, develop, manage and execute NPOSR program activities. Funding is also included for reimbursement to the Department of Defense (DOD) for 8 military officers currently serving with the NPOSR progam.

a) Headquarters	1,448	1,448	1,664

This request provides funding for salaries and benefits ($1,124,000), travel ($100,000), training and miscellaneous contractual services to support 23 FTE's located in Washington, D.C. Headquarters personnel provide overall direction and management of the Reserves, directing planning, engineering and financial functions. Specific activities include planning and program development, budget formulation and execution, accounting, procurement and contract administration, technical management reviews, engineering oversight, environmental and safety compliance, ADP planning and oversight, and personnel and administrative support. This request includes $190,000 for reimbursement to DOD for two military officers and $250,000 for support services to provide economic analyses of development projects and capital investments, engineering and technical analyses, and design and implementation of financial systems. The requested increase is due to promotions and within grades, military retirement accrual contributions for which reimbursement has been required since FY 1985, and engineering and economic analyses required to support continued field development.

		FY 1986 Appropriation	FY 1987 Base	FY 1987 Request
b)	NPR-1	$3,244	$3,244	$2,875

This request provides funding for salaries and benefits ($2,283,000), travel ($67,000), training and miscellaneous contractual services to support 56 FTE's located at Elk Hills, California. These FTE's provide for on-site management of the field. The staffing requested provides for management, administrative support, financial management, contract administration, and petroleum, construction and drilling engineering. Major activities performed by field personnel include determining the maximum efficient rates of production for each reservoir; determining the Government's equity share of the resources; determining the number, location and type of wells to be drilled; determining and scheduling wells for the remedial workover program; establishing requirements and directing the NPRC facilities construction program; developing and directing NPRC EOR programs; determining gas injection and waterflood programs; and production and sales accounting. Included in this request is reimbursement to DOD for 4 military officers ($240,000). The decrease requested is due to a decrease in FTE's resulting from the transfer of certain functions to the management and operating contractor.

c)	NPR-3 & NOSRs	735	735	835

This request provides funding for salaries and benefits ($609,000), travel ($54,000), training and miscellaneous contractual services to support 16 FTE's located at Casper, Wyoming. These FTE's provide for the overall management of the field, and establishing the maximum efficient rates for the production of crude oil. These FTE's include staffing for management, finance and administration, petroleum engineering, and contract surveillance including procurement and property management. NPR-3 is also responsible for the daily management and monitoring of NOSR activities. Miscellaneous contractual services include rent, utilities, PCS moves, printing, materials and supplies. Included in this request is reimbursement to DOD for two military officers ($110,000). The requested increase is due to within grades and reimbursement for military retirement.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
OPERATING EXPENSE FUNDED PROJECT DATA SHEET
FOSSIL ENERGY

Naval Petroleum and Oil Shale Reserves

(Tabular dollars in thousands. Narrative material in whole dollars.)

Stevens Artificial Lift for FY 1987
Naval Petroleum Reserves Nos. 1 & 2
California

Total Estimated Cost (TEC) $4,883,000

STEVENS ARTIFICIAL LIFT FOR FY 1987
Naval Petroleum Reserves Nos. 1 & 2

Total Estimated Cost (TEC) $4,883,000

(Tabular dollars in thousands. Narrative material in whole dollars)

Operating Expenses (DOE)	Cumulative Prior Years OBS.	FY 1987 Estimate B/A	FY 1987 Estimate B/O	Total Cost B/A
Design and Construction	0	$1,450	$1,450	$1,450
R&D Related to Construction	0	0	0	0
Facility Operations	0	0	0	0
Direct Project Related Support Costs	0	0	0	0
Capital Equipment	0	$3,433	$3,433	$3,433
Total Operating Expenses	0	$4,883	$4,883	$4,883
Other DOE funding	0	0	0	0
Total DOE Funding	0	$4,883	$4,883	$4,883
Non-DOE funding	0	0	0	0
Total Project Funding	0	$4,883	$4,883	$4,883

Description, Objective, and Justification

Purchase and install variable speed electric submersible pumping units in 20 Stevens wells, mainly in the 31S Structure. Equipment to be installed includes 150 hp multi-stage, variable speed, high voltage (approx. 2900 VAC) centrifugal submersible pumps, equipped with gas separators and seal sections, pump cable, wellhead, control panel, transformers, and overhead power from main distribution system.

STEVENS ARTIFICIAL LIFT FOR FY 1987
Naval Petroleum Reserves Nos. 1 & 2

Total Estimated Cost (TEC) $4,883,000

(Tabular dollars in thousands. Narrative material in whole dollars)

Description, Objectives and Justification

Purchase and install rod pumping units and related equipment in 10 Stevens wells located in the 29R, NWR, 24Z and 26R structures. Equipment to be installed includes rod pump, rods, wellhead, beam-type pumping unit with 50 hp electric driver, concrete base, electric controls, transformers, and overhead power from main distribution system.

Due to the response of the waterflood and declining reservoir pressures, it will be necessary to install artificial lift equipment in 30 Stevens wells to maintain oil production. The following tabulation shows the various Stevens Zone pools at NPR #1, the total number of producing wells, and the total number of wells estimated to require artificial lift equipment.

Structure or Pool	Total Producing Wells		Total Wells Estimated to Require Artificial Lift	
	FY 1986	FY 1987	FY 1986	FY 1987
29R	51	52	44	47
31S	187	189	76	96
NWR	76	76	46	50
24Z	30	30	10	11
26R	57	59	6	7
2B	7	7	6	7
Total	408*	413*	188	218

*Contingent upon drilling program.

The above tabulations show that it will be necessary to install artificial lift equipment to produce 30 Stevens wells in FY 1987. Based on an estimated average producing rate of 50 BOPD, the artificial lift equipment is paid out in 4.74 months.

STEVENS ARTIFICIAL LIFT FOR FY 1987
Naval Petroleum Reserves Nos. 1 & 2

Total Estimated Cost (TEC) $4,883,000

(Tabular dollars in thousands. Narrative material in whole dollars)

(a) Schedule of Planned Activities

Activity	Start	Complete
1. Committment	1Q FY 1987	4Q FY 1987
2. Order Equipment	1Q FY 1987	4Q FY 1987
3. Receive Equipment	1Q FY 1987	4Q FY 1987
4. Detailed Design	1Q FY 1987	4Q FY 1987
5. Procure Construction Subcontractor	1Q FY 1987	4Q FY 1987
6. Construction	1Q FY 1987	4Q FY 1987

Note: Artificial lift equipment will be installed on an individual well basis as justified by reservoir conditions and maximum efficient production rate determinations. Therefore, funds for prior and subsequent years will not be addressed, and schedules for individual wells cannot be addressed.

(b) Management and Contracting

Engineering, design, construction, cost controls, etc., will be primarily the management responsibility of the Unit Operator with broad oversight monitoring direction to be given by the staff of the Owners, Department of Energy and Chevron. Contracting and purchasing arrangements have not been finalized, but will probably be fixed-price subcontract awarded on the basis of competitive bidding. Quality control will be in accordance with all agency quality control program requirements. Project is to conform in all respects to all laws, regulations and other requirements governing occupational safety and health and protection of the environment.

(c) Prior Year Achievements

Not applicable

(d) Current Year Achievements

Not applicable

(e) Reasons for Increases or Decreases

Not applicable

STEVENS ARTIFICIAL LIFT FOR FY 1987
Naval Petroleum Reserves Nos. 1 & 2

Total Estimated Cost (TEC) $4,883,000

(Tabular dollars in thousands. Narrative material in whole dollars)

(f) Cost Estimate

Engineering & Design	$ 480,000
Equipment & Installation	4,140,000
Construction Management	50,000
Utilities	213,000
TOTAL	$ 4,883,000

NOTE: Increase in operating expense, maintenance, and G&A costs are estimated to be the projected field wide lifting cost of approximately $3.50/BOPD.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET
FOSSIL ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES

KEY ACTIVITY SUMMARY

Key Activity	Actual Activities During FY 1985	Estimated Activites During FY 1986	Planned Activites During FY 1987
Reserves Nos. 1&2 (California, management and operating contractor is Becthel Petroleum Operations, Inc.)	Continue routine operation and maintenance activities on production, collection, storage and distribution systems; supervise drilling and downhole well work programs; operate water production, disposal and injection systems; manage enhanced recovery programs; operate and maintain three gas plants and associated facilities which process approximately 350 MMCF/D of natural gas. ($25.3 million).	Contine routine operation and maintenance activities on production, collection, storage and distribution systems; supervise drilling and downhole well work programs; operate water production, disposal and injection systems; manage enhanced recovery programs; operate and maintain three gas plants and associated facilities which process approximately 350 MMCF/D of natural gas. ($40.4 million).	Continue routine operation and maintenance activities on production, collection, storage and distribution stems; supervise drilling and downhole well work programs; operate water production, disposal and injection systems; manage enhanced recovery programs, operate and maintain three gas plants and associated facilities which process approximately 350 MMCF/D of natural gas. ($39.0 million).
	Completed 128 major remedial well workover jobs ($8.9 million).	Complete 164 major remedial workover jobs ($10.9 million).	Complete 166 major remedial well workover jobs ($14.4 million).
	Continue technical services including reservoir engineering, geological studies, laboratory services, electricity, engineering, drafting, corrosion control, cathodic protection, construction and telecommunications. ($12.0 million).	Continue technical services including reservoir engineering, geological studies, laboratory services, electricity, engineering, drafting, corrosion control, cathodic protection, construction and telecommunications. ($19.5 million).	Continue technical services including reservoir engineering, geological studies, laboratory services, electricity, engineering, drafting, corrosion control, cathodic protection, construction and telecommunications. ($19.1 million).

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET
FOSSIL ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES

KEY ACTIVITY SUMMARY (continued)

Key Activity	Actual Activities During FY 1985	Estimated Activities During FY 1986	Planned Activities During FY 1987
	Continue required administrative support services including financial, accounting, legal, ADP, safety and security ($15.1 million).	Continue required administrative support services including financial, accounting, legal, ADP, safety and security ($24.0 million).	Continue required administrative support services including financial, accounting, legal, ADP, safety and security ($23.1 million).
	Drilled 22 development wells ($11.3 million of prior year funds).	Drill 46 development wells with increased water injectors and EOR wells ($17.9 million).	Drill 35 development wells with water injection and producer wells ($22.9 million).
	Constructed facilities for artificial lift, modifications to current production systems and environmental and safety requirements ($4.5 million of prior year funds).	Construct facilities for artificial lift, modifications to current production systems and environmental and safety requirements ($8.0 million).	Construct facilities for waterflood recovery, artificial lift, modifications to current production systems and environmental and safety requirements ($8.0 million).
	Initiated deep test well ($8.9 million including $6.0 million of prior year funds).	Drill second half of deep test well, complete and test potential pay zones ($9.9 million).	Drill and test Carneros exploratory well ($3.8 million).
	Produced an average of 131,000 BOPD, 369 MMCF/D of natural gas, and 683 MGAL/D of liquid products.	Produce an estimated 128,000 BOPD, 375 MMFC/D of natural gas and 700 MGAL/D of liquid products.	Produce an estimated 113,000 BOPD, 335 MMCF/D of natural gas and 590 MGAL/D of liquid products.

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET
FOSSIL ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES

KEY ACTIVITY SUMMARY(continued)

Key Activity	Actual Activities During FY 1985	Estimated Activities During FY 1986	Planned Activities During FY 1987
	Sold an average of 102,000 BOPD, 127 MMCF/D of natural gas and 547 MGAL/D of liquid products.	Sell an estimated 101,000 BOPD, 160 MMCF/D of natural gas and 604 MGAL/D of liquid products.	Sell an estimated 88,000 BOPD, 150 MMCF/D of natural gas and 509 MGAL/D of liquid products.
	Generated gross revenues of $1,267.7 million.	Generate estimated gross revenues of $1,223.4 million.	Generate estimated gross revenues of $1,070.3 million.
	Continue on-site management including engineering, construction, financial, planning, ADP, and administrative support services ($3.3 million).	Continue on-site management including engineering, construction, financial, planning, ADP, and administrative support services ($3.2 million).	Continue on-site management including engineering, construction, financial, planning, ADP, and administrative support services ($2.9 million).
Reserve No. 3 (Wyoming, contractor is Lawrence-Allison & Associates West, Inc.)	Continue routine operation and maintenance activities on production, collection, storage and distribution systems; well work; gas plant; and enhanced recovery ($5.9 million).	Continue routine operation and maintenance activities on production, collection, storage and distribution systems; well work; gas plant; and enhanced recovery ($13.1 million).	Continue routine operation and maintenance activities on production, collection, storage and distribution systems; well work; gas plant; and enhanced recovery ($9.3 million).
	Provide management and administrative support services including engineering, geology, financial, ADP, security, safety and environment ($4.0 million).	Provide management and administrative support services including engineering, geology, financial, ADP, security, safety and environment ($7.0 million).	Provide management and administrative support services including engineering, geology, financial, ADP, security, safety and environment ($6.3 million).

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET
FOSSIL ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES

KEY ACTIVITY SUMMARY(continued)

Key Activity	Actual Activities During FY 1985	Estimated Activities During FY 1986	Planned Activities During FY 1987
	Drilled 32 development wells to continue development and production of the Reserve ($4.1 million).	Drill 20 development wells to develop deeper zones ($4.0 million).	Drill 22 development wells to continue and enhance development of deeper zones, and 30 wells to initiate Shannon infill drilling program ($6.8 million).
	Completed construction and installation of facilities for EOR projects ($3.6 million).	Initiate 3 enhanced recovery projects to maintain and/or increase production ($5.0 million).	Develop plans and designs for expansion of Shannon enhanced recovery techinques ($.2 million).
	Produced an average of 2,907 BOPD, 8 MMCF/D of natural gas (for injection only) and 14 MGAL/D of liquid products.	Produce an estimated 2,800 BOPD, 10 MMCF/D of natural gas (for injection only) and 15 MGAL/D of liquid products.	Produce an estimated 2,800 BOPD, 10 MMCF/D of natural gas (for injection only) and 15 MGAL/D of liquid products.
	Generated revenues of $31.5 million.	Generate estimated revenues of $29.8 million.	Generate estimated revenues of $29.2 million.
	Continue on-site management including engineering, financial, planning, ADP and administrative support services ($.7 million).	Continue on-site management including engineering, financial, planning, ADP, and administrative support services ($.7 million).	Continue on-site management including engineering, financial, planning, ADP, and administrative support services ($.8 million).

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET
FOSSIL ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES

KEY ACTIVITY SUMMARY(continued)

Key Activity	Actual Activities During FY 1985	Estimated Activities During FY 1986	Planned Activities During FY 1987
Shale Reserves (Colorado and Utah)	Continue land management, security and minor maintenance activities ($.1 million).	Continue land management, security and minor maintenance activities ($.1 million).	Continue land management activities ($.1 million).
	Drill second well to protect natural gas resources at NOSR-3 ($1.2 million).	Pending data verification from FY 1984 drilling, drill 6 development wells to protect natural gas resources at NOSR-3 ($3.6 million).	Drill 6 development wells at NOSR-3 to complete natural gas resources protection plan ($4.9 million).
	Complete decommissioning of Anvil Points facility ($2.8 million).		Mitigate adverse environmental conditions from spent oil shale pile ($.2 million).
		Generate estimated revenues of $1.6 million from the sale of natural gas.	Generate estimated revenues of $5.6 million from the sale of natural gas.
Headquarters (Washington, D.C.)	Continue to provide for overall management of the Reserves including engineering, facilities, planning, financial, ADP, procurement, personnel, environmental and safety support ($1.8 million).	Continue to provide for overall management of the Reserves including engineering, facilities, planning, financial, ADP, procurement, personnel, environmental and safety support ($1.5 million).	Continue to provide for overall management of the Reserves including engineering, facilities, planning, financial, ADP, procurement, personnel, environmental and safety support ($1.7 million).

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
AMOUNTS AVAILABLE FOR OBLIGATION
NAVAL PETROLEUM AND OIL SHALE RESERVES
(In thousands of dollars)

	1986	1987
Appropriation	$ 13,002	$ 127,108
Receipts and Reimbursements:		
Unobligated Balances, Start of Year	209,000	52,370
Unobligated Balances, End of Year	- 52,370	-15,909
Total, Obligations	$ 169,632	$ 163,569

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Petroleum Reserves Nos. 1&2 - Object Class
(Dollar amounts in thousands)

		1985 Actual	1986 Estimate	1987 Estimate
Direct obligations:				
11.0	Personnel compensation:			
11.1	Full-time permanent.....	2,268	2,178	1,948
11.3	Other than full-time permanent.....	38	---	---
11.5	Other personnel compensation.....	51	88	85
11.8	Special personal services payments.....	181	240	240
	Total personnel compensation.....	2,538	2,506	2,273
12.1	Personnel benefits: civilian.....	265	240	250
13.0	Benefits for former personnel.....	7	---	---
21.0	Travel and transportation of persons.....	83	70	67
22.0	Transportation of things.....	10	24	18
23.3	Communications, utilities, and other rent.....	20	70	70
24.0	Printing and reproduction...	---	---	2
25.0	Other services.....	66,235	130,728	130,490
26.0	Supplies and materials.....	55	32	45
	Total direct obligations.....	69,213	133,670	133,215

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Petroleum Reserves Nos. 1&2 - Object Class
(Dollar amounts in thousands)

		FY 1987 Base		FY 1987 Estimate		Increase (+) or decrease (-)	
		FTE	Amount	FTE	Amount	FTE	Amount
Direct obligations:							
11.0	Personnel compensation:						
11.1	Full-time permanent.....	65	2,178	56	1,948	- 9	-230
11.5	Other personnel compensation.....	---	88	---	85	---	- 3
11.8	Special personal services payments.....	---	240	---	240	---	---
	Total personnel compensation.....	65	2,506	56	2,273	- 9	-233
12.1	Personnel benefits: civilian.....	---	240	---	250	---	+ 10
21.0	Travel and transportation of persons.....	---	70	---	67	---	- 3
22.0	Transportation of things.....	---	24	---	18	---	- 6
23.3	Communications, utilities, and other rent.....	---	70	---	70	---	---
24.0	Printing and reproduction.....	---	---	---	2	---	+ 2
25.0	Other services.....	---	130,728	---	130,490	---	-238
26.0	Supplies and materials.....	---	32	---	45	---	+ 13
	Total direct obligations.....	65	133,670	56	133,215	- 9	-455

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Petroleum Reserves No. 3 - Object Class
(Dollar amounts in thousands)

		1985 Actual	1986 Estimate	1987 Estimate
Direct obligations:				
11.0	Personnel compensation:			
11.1	Full-time permanent.....	429	471	530
11.5	Other personnel compensation.....	7	8	10
11.8	Special personal services payments.....	110	110	110
	Total personnel compensation.....	546	589	650
12.1	Personnel benefits: civilian.....	55	51	69
21.0	Travel and transportation of persons.....	43	44	54
22.0	Transportation of things.....	2	10	3
23.2	Rental payments to others.....	6	10	10
23.3	Communications, utilities, and other rent.....	9	12	13
24.0	Printing and reproduction.....	1	1	2
25.0	Other services.....	17,581	29,094	22,637
26.0	Supplies and materials.....	30	11	11
	Total direct obligations.....	18,273	29,822	23,449

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Petroleum Reserves No. 3 - Object Class
(Dollar amounts in thousands)

		FY 1987 base		FY 1987 Estimate		Increase (+) or decrease (-)	
		FTE	Amount	FTE	Amount	FTE	Amount
Direct obligations:							
11.0	Personnel compensation:						
11.1	Full-time permanent....	16	471	16	530	---	+ 59
11.5	Other personnel compensation.....	---	8	---	10	---	+ 2
11.8	Special personal services payments....	---	110	---	110	---	---
	Total personnel compensation.....	16	589	16	650	---	+ 61
12.1	Personnel benefits: civilian.....	---	51	---	69	---	+ 18
21.0	Travel and transportation of persons.....	---	44	---	54	---	+ 10
22.0	Transportation of things.....	---	10	---	3	---	- 7
23.2	Rental payments to others.....	---	10	---	10	---	---
23.3	Communications, utilities, and other rent.....	---	12	---	13	---	+ 1
24.0	Printing and reproduction.....	---	1	---	2	---	+ 1
25.0	Other services.....	---	29,094	---	22,637	---	- 6,457
26.0	Supplies and materials.....	---	11	---	11	---	---
	Total direct obligations.....	16	29,822	16	23,449	---	- 6,373

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Oil Shale Reserves - Object Class
(Dollar amounts in thousands)

		1985 Actual	1986 Estimate	1987 Estimate
Direct obligations:				
25.0	Other services.....	4,225	4,565	5,241
	Total direct obligations.....	4,225	4,565	5,241

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Naval Oil Shale Reserves - Object Class
(Dollar amounts in thousands)

		FY 1987 Base		FY 1987 Estimate		Increase (+) or decrease (-)	
		FTE	Amount	FTE	Amount	FTE	Amount
Direct obligations:							
25.0	Other services.....	---	4,565	---	5,241	---	+ 676
	Total direct obligations.....	---	4,565	---	5,241	---	+ 676

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Headquarters - Object Class
(Dollar amounts in thousands)

		1985 Actual	1986 Estimate	1987 Estimate
Direct obligations:				
11.0	Personnel compensation:			
11.1	Full-time permanent.....	882	926	962
11.3	Other than full-time permanent.....	38	40	36
11.5	Other personnel compensation.....	13	20	20
11.8	Special personal services payments.....	260	190	190
	Total personnel compensation.....	1,193	1,176	1,208
12.1	Personnel benefits: civilian.....	117	103	106
21.0	Travel and transportation of persons.....	84	100	100
25.0	Other services.....	461	196	250
	Total direct obligations.....	1,855	1,575	1,664

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
NAVAL PETROLEUM AND OIL SHALE RESERVES

Headquarters - Object Class
(Dollar amounts in thousands)

		FY 1987 Base		FY 1987 Estimate		Increase (+) or decrease (-)	
		FTE	Amount	FTE	Amount	FTE	Amount
Direct obligations:							
11.0	Personnel compensation:						
11.1	Full-time permanent.....	22	926	22	962	---	+ 36
11.3	Other than full-time permanent.....	1	40	1	36	---	- 4
11.5	Other personnel compensation.....	---	20	---	20	---	---
11.8	Special personal services payments.....	---	190	---	190	---	---
	Total personnel compensation.....	23	1,176	23	1,208	---	+ 32
12.1	Personnel benefits: civilian.....	---	103	---	106	---	+ 3
21.0	Travel and transportation of persons.....	---	100	---	100	---	---
25.0	Other services.....	---	196	---	250	---	+ 54
	Total direct obligations.....	23	1,575	23	1,664	---	+ 89

DEPARTMENT OF ENERGY
NAVAL PETROLEUM AND OIL SHALE RESERVES
PROGRAM AND FINANCING SCHEDULE
(in thousands of dollars)

Identification Code 89-0219-0-1-271	1985 actual	1986 est.	1987 est.
Program by activities:			
00.01 Naval petroleum and oil shale reserves	93,566	169,632	163,569
00.03 Commercialization support	10	---	---
10.00 Total obligations	93,576	169,632	163,569
Financing:			
17.00 Recovery of prior year obligations	-8,014	---	---
21.40 Unobligated balance available, start of year	-140,351	-209,000	-52,370
22.40 Unobligated balance transferred, net	2,500	---	---
24.40 Unobligated balance available, end of year	209,000	52,370	15,909
25.00 Unobligated balance lapsing	163	---	---
40.00 Budget authority (appropriation)	156,874	13,002	127,108
Relation of obligations to outlays:			
71.00 Obligations incurred, net	93,576	169,632	163,569
72.40 Obligated balance, start of year	130,751	63,010	68,831
74.40 Obligated balance, end of year	-63,010	-68,831	-66,100
78.00 Adjustments in unexpired accounts	- 8,014	---	---
90.00 Outlays	153,303	163,811	166,300

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF PERSONNEL RESOURCES
NAVAL PETROLEUM AND OIL SHALE RESERVES
FY 1985 ACTUAL OBLIGATIONS
(Dollar Amounts in Whole Thousands)

Appropriation/Program	Full-Time Equivalents FTP	Full-Time Equivalents Total	FTP Base Salaries	Other Personnel Compensation	Benefits	Travel of Persons	Contractual Services	Total
Naval Petroleum and Oil Shale Reserves								
Reserves Nos. 1 & 2	66	68	$2,268	$270	$272	$ 83	$ 66,320	$ 69,213
Reserve No. 3	13	13	429	117	55	43	17,629	18,273
Naval Oil Shale Reserves	---	---	---	---	---	---	4,225	4,225
Headquarters	22	23	882	311	117	84	461	1,855
Grand Total								
Headquarters	22	23	$ 882	$311	$117	$ 84	$ 461	$ 1,855
Field Offices	79	81	2,697	387	327	126	88,174	91,711
Total	101	104	$3,579	$698	$444	$210	$ 88,635	$ 93,566

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF PERSONNEL RESOURCES
NAVAL PETROLEUM AND OIL SHALE RESERVES
FY 1986 ESTIMATED OBLIGATIONS
(Dollar Amounts in Whole Thousands)

Appropriation/Program	Full-Time Equivalents FTP	Full-Time Equivalents Total	FTP Base Salaries	Other Personnel Compensation	Benefits	Travel of Persons	Contractual Services	Total
Naval Petroleum and Oil Shale Reserves								
Reserves Nos. 1 & 2	65	65	$2,178	$328	$240	$ 70	$130,854	$133,670
Reserve No. 3	16	16	471	118	51	44	29,138	29,822
Naval Oil Shale Reserves	---	---	---	---	---	---	4,565	4,565
Headquarters	22	23	926	250	103	100	196	1,575
Grand Total								
Headquarters	22	23	$ 926	$250	$103	$100	$ 196	$ 1,575
Field Offices	81	81	2,649	446	291	114	164,557	168,057
Total	103	104	$3,575	$696	$394	$214	$164,753	$169,632

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF PERSONNEL RESOURCES
NAVAL PETROLEUM AND OIL SHALE RESERVES
FY 1987 ESTIMATED OBLIGATIONS
(Dollar Amounts in Whole Thousands)

Appropriation/Program	Full-Time Equivalents FTP	Full-Time Equivalents Total	FTP Base Salaries	Other Personnel Compensation	Benefits	Travel of Persons	Contractual Services	Total
Naval Petroleum and Oil Shale Reserves								
Reserves Nos. 1 & 2	56	56	$1,948	$325	$250	$ 67	$130,625	$133,215
Reserve No. 3	16	16	530	120	69	54	22,676	23,449
Naval Oil Shale Reserves	---	---	---	---	---	---	5,241	5,241
Headquarters	22	23	962	246	106	100	250	1,664
Grand Total								
Headquarters	22	23	$ 962	$246	$106	$100	$ 250	$ 1,664
Field Offices	72	72	2,478	445	319	121	158,542	161,905
Total	94	95	$3,440	$691	$425	$221	$158,792	$163,569

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
1987 CONTRACT LISTING
NAVAL PETROLEUM AND OIL SHALE RESERVES
(In thousands of dollars)

	Estimated Amount
Reserves Nos. 1 & 2	
o Unit operator	$130,340
Reserve No. 3	
o Contractor/operator	$ 21,258
o Motor pool services	209
o Electric utility services	1,147
Subtotal	$ 22,614
Naval Oil Shale Reserves	
o Land management	$ 50
o Ruedi Reservoir water rights (maintenance fee)	10
o Contractor/operator (NOSR-3 gas wells)	4,931
o Environmental mitigation (spent shale pile)	250
Subtotal	$ 5,241
Program Direction	
o Technical and administrative support services	$ 250
Total NPOSR	$158,445